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109 — Journal Section of the American Society of Heating and Ventilating Engineers

The job evaluation engineer's function is to appraise conditions —the heating, ventilating, and air conditioning engineer controls them

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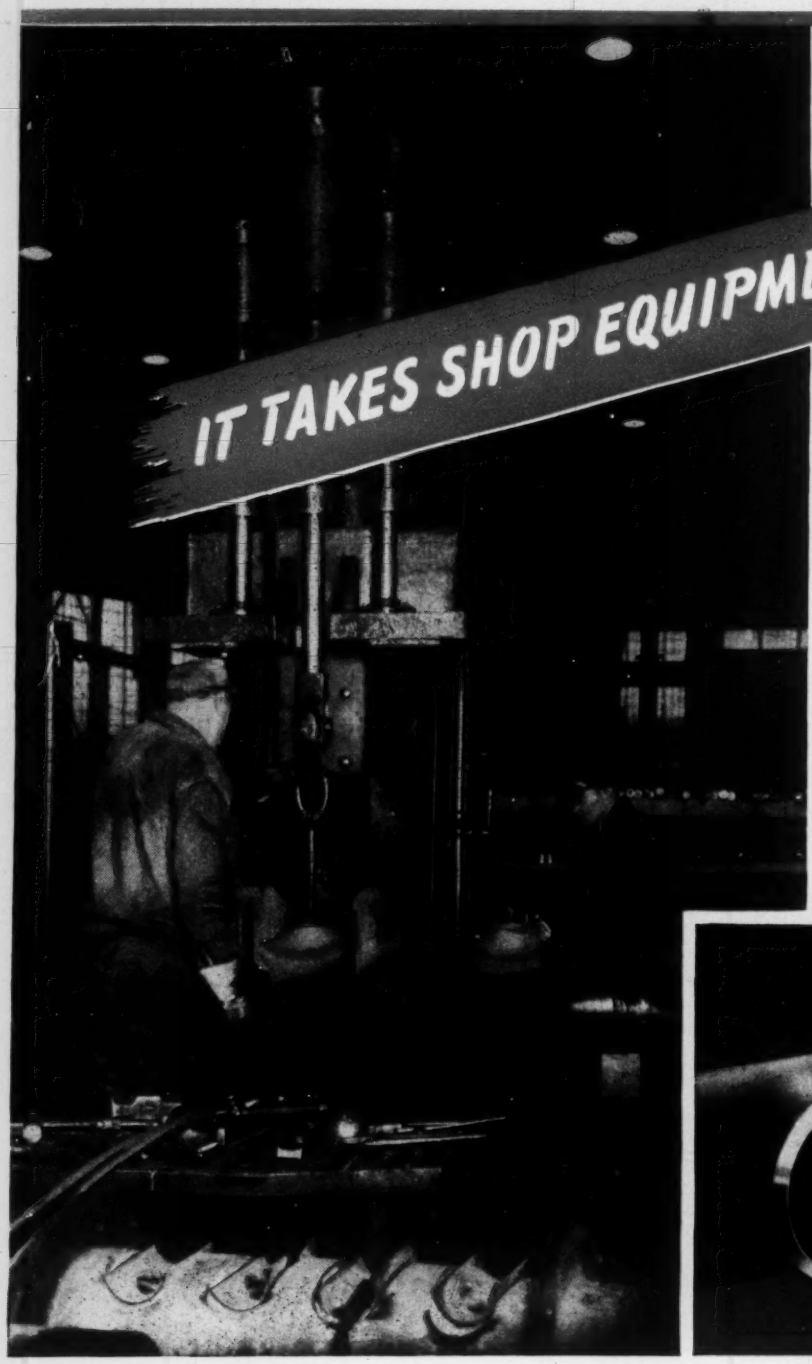

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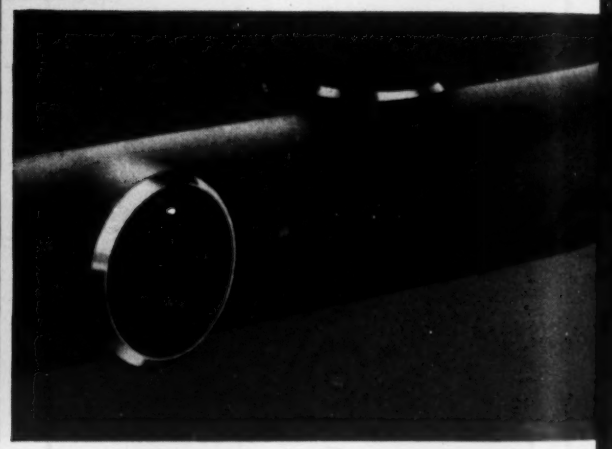

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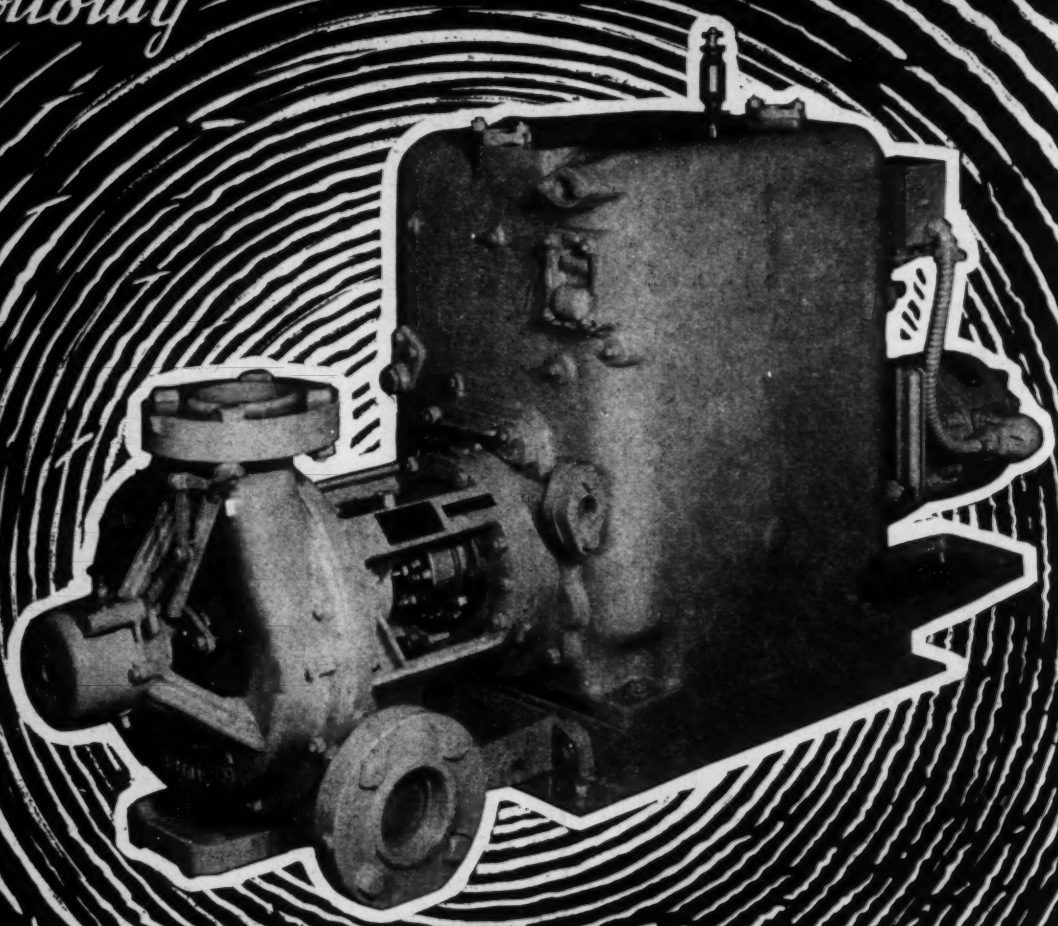
Centralized Heating Economy



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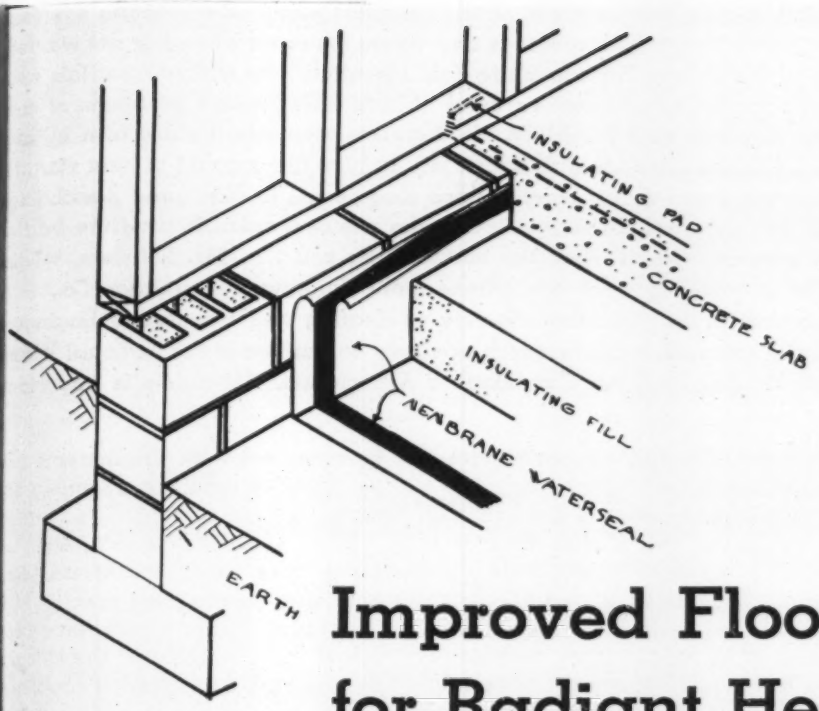


Improved Floor Construction for Radiant Heating Systems

John E. Peterson Analyzes Downward Heat Flow, Suggests Use of Insulating Fill and Membrane

FIELD investigations conducted last winter by the author's company on the control of radiant panel heating systems point to the need for consideration of the heat which is stored in the areas below floor panels.

Since radiant panel heating often results in adding to the mass of the heating medium in the form of a masonry slab and a fill area below—such as soil or other similar fill material in contact with the slab—the heat storage capacity of the heating system is increased. This storage presents problems of response and flexibility. Control systems have been developed which provide continuous input of heat by cycling the burner at whatever frequency the heat load at any particular time requires so that the average temperature of the heating medium is commensurate with the heat load. These control systems overcome the mass of conventional systems and easily follow weather cycles.

As the mass of the heating medium is increased, it becomes more difficult for the control system and the heating system to readjust themselves or get into step with changing heat loads. A heating system with great mass, in a structure which responds quickly to variations of weather—such as sun effect on a building of "solar construction," as an extreme example—presents a problem of heat storage with which it is difficult for the control system to cope.

Sun Has Pronounced Effect

Our investigations were conducted in modern structures with generous window areas. In one case the building was of solar type, which would require quick temperature changes of the heating medium if the system were to cope with the changes in heat load. While the requirement for quick change of heating medium temperature was most pronounced with the solar type of construction, it was of interest to note the marked sun effect on burner cycles and room temperature with conventional construction, too. In each case, the winter sun and reversal of heat flow from storage raised the room temperature substantially above the comfort level.

Once operation leveled out with a steady heat load, temperature distribution in most areas was satisfactory but areas adjacent to large window areas were not always comfortable; the need for thermal treatment or consideration of large window areas is thus indicated. However, this article is not concerned with the merits or faults of radiant panel systems and a discussion of room temperatures and comfort conditions will not be given.

Downward Heat Flow Not Negligible

The downward heat flow into the fill area under a heated concrete slab has often been referred

to as a negligible quantity and it has been said that once this area has been heated, heat flow is in a steady state—that is to say, once the "investment" is made in heat storage, further heat loss is negligible. This theory is based on a relatively constant temperature at the under surface of the slab, but our investigations proved that the weather changes with sufficient frequency to present a condition of unsteady state. This means that there are frequent changes—from storing Btu's in the floor slab and fill to reversal of heat flow from this mass.

The cycle of storing and reversal of heat flow may occur as frequently as once in successive 24 hr intervals. The amount of heat stored becomes a serious consideration because our observations revealed that these heat units are lost by being dissipated through the foundation, below the surface, to the surrounding soil at the perimeter of the structure, and by reverse flow of heat into the building at a time when no heat from the floor was required. It was observed that the loss into the surrounding soil was in addition to the edge loss of the heated slab because the latter heat was dissipated largely to the atmosphere at the exposed edges. The reversal of heat flow from storage cannot be controlled in accordance with the heat load at any particular time.

Empirical data emphasizing the importance of this storage problem may be summarized by saying that ice, snow, and frost were found to be melted 2 ft distant from several structures; this condition has been confirmed by other observers. Room temperatures mounted as high as 97 F during sunny days, requiring ventilation for relief. Fuel input did not reflect the Btu load, nor the degree days. Each of these conditions confirms the importance of the problem of heat storage and it is the intent of this article to suggest a solution.

Reduce Amount of Heat Storage

Solving the problem of heat storage and resultant ground losses and reversal of heat flow, appears to be possible by reducing the amount of heat storage through the use of suitable fill materials.

FLOW OF HEAT downward into the floor slab and the fill or soil underneath it complicates the control of radiant panel floor heating systems since this stored heat reverses and enters the room when it is not wanted, says the author. He has made field investigations which show this heat storage and subsequent reversal of heat flow present problems of control response and flexibility. He therefore suggests the use of a fill material under the floor slab which will reduce the amount of heat storage, and has found that a blast furnace slag seems to offer good possibilities for this purpose. He suggests also the use of a suitable moisture barrier to separate the fill from the surrounding soil . . . Mr. Peterson, whose title is research engineer, Minneapolis-Honeywell Regulator Co., is a member of the American Society of Heating and Ventilating Engineers and a member of the research advisory committee of the National Warm Air Heating and Air Conditioning Association. His article is important

Since the materials used in the construction of a slab floor are of the masonry type, it is difficult to envision a material that would be applicable and at the same time would give resistance to heat flow. Masonry materials are heavy, and we usually associate such materials with high thermal conductivity and storage capacity. But investigation indicates several materials can be utilized to provide resistance to heat flow and at the same time be suitable for application to slab floors.

The best analysis of the comparative values of such materials would be given by test data from two identical structures situated as closely as possible to each other, but with different fill construction under the floor heating panels. This would permit plotting temperature-distance-time curves for each case and then (by the rules of calculus) determining rates of heat flow, storage, etc. Analysis of structures not in proximity to each other would be erroneous, unless the complexity of the analysis were increased further by introducing the variable moisture content of the underlying soil into the equations. Soil composition and moisture content vary with location and, since each changes the k value of a substance, it is apparent that heat storage will vary with location.

A mathematical approach to this problem has the advantage that known and relatively fixed values may be assigned to elements entering into the equation and the results for an ideal condition may be compared with the extreme and yet possible condition found in the field.

This approach is practical because it is based on thermal conductivity, density, and specific heat—physical values which have been found to be reliable in the calculation of heat transmission problems.

Fills For Radiant Slab Panels

Table 1 gives the thermal conductivity and density values for different fill materials. In the case of soils, they are considered as fills because they occupy the same position below the panel as the other fill materials. The high rate of conductivity for clay with 2[illegible] per cent moisture discloses the importance of moisture at the building site. Most slab areas are partially excavated or scraped and the slab lies on a clay base of unknown moisture content. The minimum value for soil may be an optimum with respect to composition and moisture content. A mean between minimum soil and clay with 28 per cent moisture has been calculated and may serve as a practical mean if it is desired to calculate values in the equation for practical comparisons.

The low value in Table 1 for air cooled blast furnace slag suggests excellent possibilities for use of this material as a fill below radiant slab heating panels.

Fig. 1 shows curves of temperature vs. distance, and Table [illegible] indicates the time values in hours for clay, minimum soil, and slag. From Table 2, it is noted that it requires approximately 7 hr for the slag fill to attain the same temperature curve that the clay fill attains in about ½ hr.

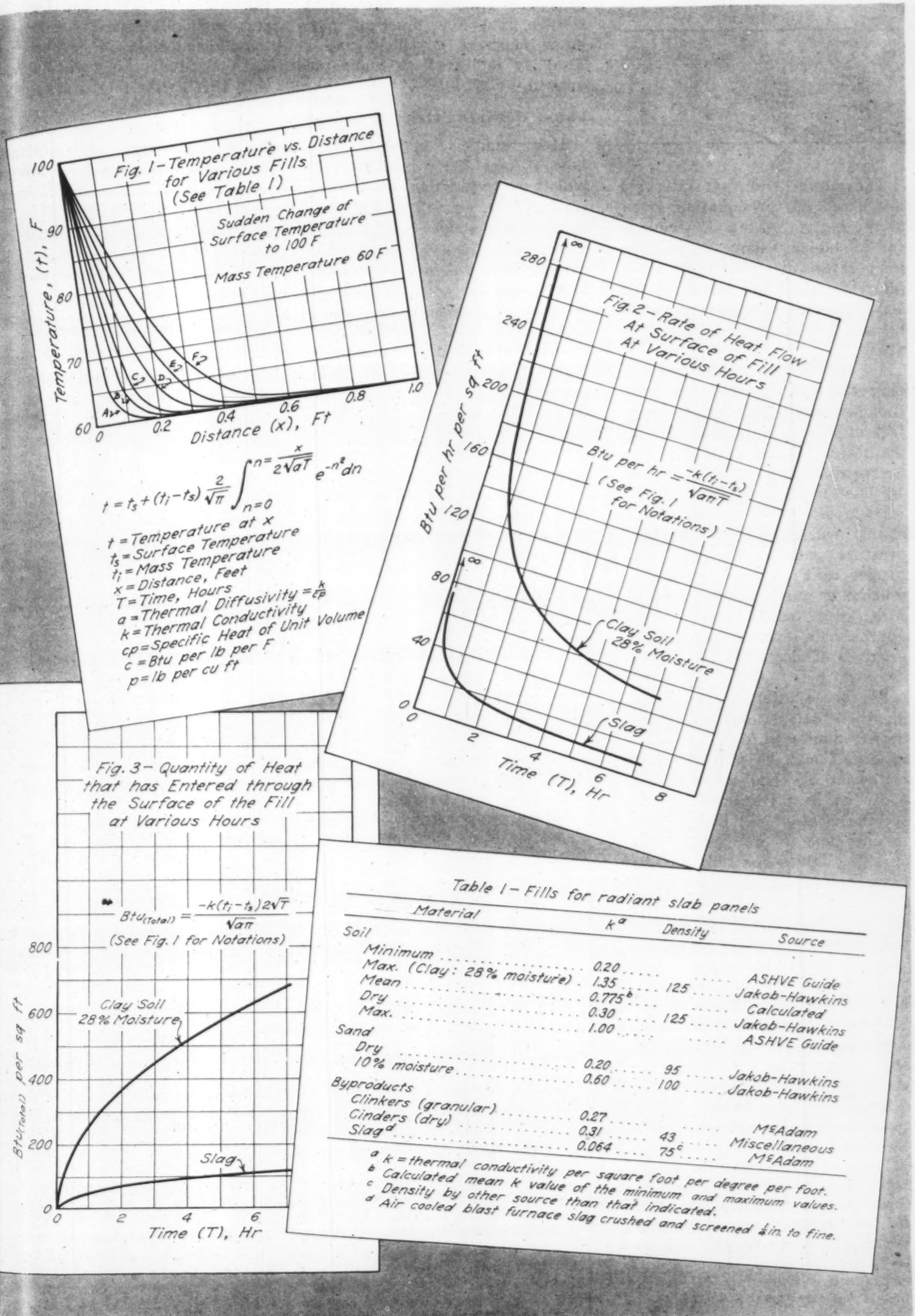


Fig. 1 – Temperature vs. Distance for Various Fills (See Table 1)
Sudden Change of Surface Temperature to 100 F
Mass Temperature 60 F
Temperature, (t), F
Distance (x), Ft
$t = t_s + (t_i - t_s)\frac{2}{\sqrt{\pi}}\int_{n=0}^{n=\frac{x}{2\sqrt{aT}}} e^{-n^2} dn$
t = Temperature at x
t_s = Surface Temperature
t_i = Mass Temperature
x = Distance, Feet
T = Time, Hours
a = Thermal Diffusivity = $\frac{k}{cp}$
k = Thermal Conductivity
cp = Specific Heat of Unit Volume
c = Btu per lb per F
p = lb per cu ft
Fig. 2 – Rate of Heat Flow At Surface of Fill At Various Hours
Btu per hr per sq ft
Btu per hr = $\frac{-k(t_i - t_s)}{\sqrt{\pi aT}}$
(See Fig. 1 for Notations)
Clay Soil 28% Moisture
Slag
Time (T), Hr
Fig. 3 – Quantity of Heat that has Entered through the Surface of the Fill at Various Hours
$Btu_{(total)} = \frac{-k(t_i - t_s)2\sqrt{T}}{\sqrt{\pi a}}$
(See Fig. 1 for Notations)
$Btu_{(total)}$ per sq ft
Clay Soil 28% Moisture
Slag
Time (T), Hr

Table 1 – Fills for radiant slab panels

Material	k[a]	Density	Source
Soil			
Minimum	0.20		ASHVE Guide
Max. (Clay: 28% moisture)	1.35	125	Jakob-Hawkins
Mean	0.775[b]		Calculated
Dry	0.30	125	Jakob-Hawkins
Max.	1.00		ASHVE Guide
Sand			
Dry	0.20	95	Jakob-Hawkins
10% moisture	0.60	100	Jakob-Hawkins
Byproducts			
Clinkers (granular)	0.27		McAdam
Cinders (dry)	0.31	43	Miscellaneous
Slag[d]	0.064	75[c]	McAdam

[a] k = thermal conductivity per square foot per degree per foot.
[b] Calculated mean k value of the minimum and maximum values.
[c] Density by other source than that indicated.
[d] Air cooled blast furnace slag crushed and screened ¼ in. to fine.

Table 2—Time Values in Hours for Fills

Curve (See Fig. 1)	Clay	Soil (Minimum)	Slag
A	3/160	⅛	¼
B	3/80	¼	½
C	3/40	½	1
D	27/160	1⅛	2¼
E	3/10	2	4
F	21/40	3½	7

The curves and time intervals are based on the equation given at the bottom of Fig. 1, which is for a sudden change of surface temperature of an infinitely thick fill. The values are computed for 100 F surface temperature of the fill and a mass temperature 60 F at the start of the heating period. Thus, if it required 100 F surface temperature of the fill to provide sufficient Btu's from the top surface of the radiant panel to meet the design heat losses, and if this temperature was suddenly applied by instantaneously heating the surface of the fill to 100 F and maintained, after ½ hr the temperature gradient for clay with 28 per cent moisture would approximate curve *F* of Fig. 1. Also, this same curve would approximate the temperature progress of slag fill after approximately 7 hr.

For those interested in checking these calculations, values for the error integral for the equation in Fig. 1 may be procured from mathematical handbooks or textbooks on heat transmission. The specific heat of air cooled blast furnace slag is not readily procurable. Values for this material have been computed on a basis of 0.21 Btu per degree per lb, according to information obtained from the Inland Steel Co.

Fig. 2 shows the rate of heat flow through the surface of the fill vs. time, comparing clay with 28 per cent moisture and slag. These curves are not presented to show actual rates of heat flow into the fill area under operating conditions, but as a comparison of the relative values of one fill with the other.

Fig. 3 is a comparison of the total amount of heat that has flowed through the surface of the fill at various times and again serves as a means to gage the comparative values of the two fills. Considering the slag fill as an ideal one, 82 per cent saving in heat loss (this is actually heat storage, but for practical purposes must be considered as a loss) is indicated as compared with the clay fill.

Use of Moisture Barrier on Ground

This analysis indicates that heat storage below radiant slab panels is a function of thermal conductivity, density, and specific heat of the material—and that the values assigned to these variables depend upon the moisture situation in the fill area. In order to assign fixed values, it is necessary to segregate the fill from the surrounding soil by use of a suitable moisture barrier, such as membranes laid on the prepared surface of the ground and impregnated with asphalt or tar in a manner similar to the accepted practices of laying a builtup roof. The membranes should be flashed to the top of the foundation walls to prevent surface water or subterranean moisture from entering the fill area. This construction assures that assigned *k* values of the fill material will be obtained, and that possibly they will improve with time as the fill material dries thoroughly.

This construction requires that the ground surface be leveled and all trenched areas filled and tamped to prevent settling and ultimate fracture of the moisture barrier. Soil pipes and other facilities extending through the surface should be flashed and reinforced in such a manner that they will withstand pressure in order to prevent leakage.

Fills of low conductivity material, such as air cooled blast furnace slag to a depth of 12 in., will insure reducing the heat loss problem to minimum, or possibly negligible, values.

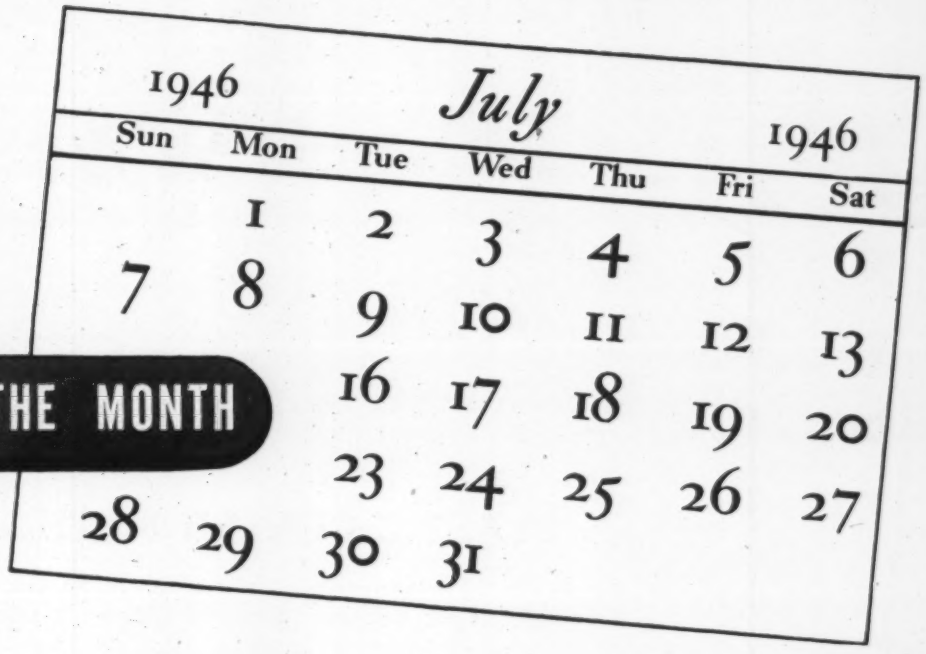
Experience with this type of construction will reveal additional advantages, such as lessening of humidity and moisture problems encountered with slab construction.

Recommends Weather-Compensated Control for Radiant Heating Jobs

The problem of controlling radiant heating systems can be solved by using a weather-compensated heat control, according to J. A. Cutler, president of Johnson Service Co., at an informal meeting of engineers held in Milwaukee recently. Such an instrument "teams up with the space temperature controls in a most satisfactory manner," he said.

"When the radiant surfaces in floors, walls, or ceilings are warmer than the space temperature, there continues to be a further increase in space temperature, after the desired level has been reached and the hot water or steam has been shut off," Mr. Cutler continued. "On the other hand, when the room requires heat and the heating surfaces are cooler than the air in the room, the space temperature continues to fall, for a time, after the hot water begins to circulate in the coils." He pointed out, in effect, that a "tip off" of variations in outdoor temperature must be relayed to the heating system in order to get less heat input when there is a change to milder outdoor temperature or increased heat input if the weather is getting colder.

The function of the weather-compensated control is to keep direct contact with the relationship between outdoor conditions and the coils in the radiant surfaces, increasing or decreasing heat input immediately, according to changes in the weather, he remarked, and said that such control starts to influence the inside temperature control system before the radiant surfaces cool or heat sufficiently to affect the temperature of the heated spaces. Therefore, with primary controls to measure the effect of changes in outdoor temperature, together with room thermostats to limit or modify the action of the primary controls, close regulation of space temperatures can be maintained, he said. The room thermostats function as high limit controllers, cutting off the supply of heat to the coils whenever the space temperature exceeds the requirement in each room, he stated.



QUESTION OF THE MONTH

What's a Flash Tank?

J. *R. K., a reader of Heating, Piping & Air Conditioning, has asked what a flash tank is, why and how is it used in heating and piping work, and what is its function. Following is an answer to his question:*

Evidently J. R. K. is not a steamfitter of the old school, accustomed to a boiler plant of reasonably high pressure, say over 50 psi, in connection with a heating system that employs a subatmospheric return.

If high pressure condensate—which, at 50 psi gage pressure is at a temperature of about 297 F—enters a vessel or pipe the interior of which is at a lower pressure, part of the water very rapidly changes state to a condition that corresponds with the new pressure. For example, if the enclosure—such as a return pipe or tank receiving the high pressure condensate—is at atmospheric pressure and does not lose heat rapidly, the entering hot water will not remain in liquid state but part of it must change to saturated steam. This is because the heat that originally brought the steam all the way up to 297 F from water at 212 F is present, and only if this heat is removed so that the condensate stabilizes as a liquid, will a pump designed to handle liquids be able to draw it in on the suction side.

How a Pump Functions

All heating system pumps must operate by reducing the pressure in the piping on the suction or inlet so that the liquid will be forced into the pump by atmospheric pressure. When the water is hotter than the boiling point at the given pressure, some of the water changes state and becomes steam; thus, the pump receives a mixture of water and steam and fails to discharge its designed duty of developing a consistent steady pressure difference between its inlet and outlet.

Why Tank Is Needed

For this reason the float trap that drains the condensate from a high pressure steam main is provided with a small tank into which the hot water escapes and wherein the water may change state or flash to superheated steam and water. From the top of this tank it is usually possible to connect a pipe to the heating system so that the reduced pressure steam may flow out of the tank and be conserved for heating the radiators.

A thermostatic trap may be connected to the bottom of the flash tank to drain the cooled condensate liquid into the vacuum return main. The flash tank should be of material capable of withstanding the full pressure of the high pressure steam main.

Size of Flash Tank

I think that the size of the flash tank usually is established by guess.

The volume of steam released from water under 50 psi gage pressure may be estimated from data obtained from a steam table:

The heat content of 1 lb of liquid under 50 psi gage pressure is 267 Btu, and under atmospheric pressure it is about 180 Btu. The difference, 87 Btu, represents the superheat in the water that can become flash steam, and the water will change state to

$(87/970) \times 26.8$ cu ft $= 2.4$ cu ft

In this equation, 970 represents

[*Concluded on page* 81]

Method of Making

PIPING FLEXIBILITY Analyses

ELASTIC CENTER METHOD

By S. W. Spielvogel, Assistant Division Engineer, Consolidated Edison Co. of New York, Inc.

THE analysis of piping expansion problems, irrespective of the method used, reverts to basic facts which may be illustrated as follows:

If a terminal point of a piping system is released from its anchorage so as to permit free expansion, the actions necessary at the free end to restore the original conditions are the reactions (anchor forces) set up when the system is under stress.

In the *elastic center method*, these actions are applied at the center of gravity of the system (centroid) instead of at the free end, assuming that the two points are joined by means of an inflexible bracket. This facilitates the solution of the problem by reducing the number of unknowns from three to two in single-plane problems, and from six to three in three-dimensional problems.

The reason for this simplification lies in the fact that the return motion from expanded to original position is accomplished by application of a single force at the centroid of the system. In contrast, if the return motion is initiated by actions applied to the actual end of the line, a moment in case of single-plane piping (or moments, in case of multiplane piping) must be applied in addition to the force, in order to restore the conditions which originally existed at the end of the line.

Summarizing, it may be said that loads upon such a free ended system, or expansion of such a system, cause the centroid to move in the same direction and with the same magnitude as the free end to which the centroid is assumed to be connected. A single force applied at the centroid will restore the original conditions. While the free end goes through a rotation, the centroid goes through translatory motion only. In other words, the moment at the centroid is zero.

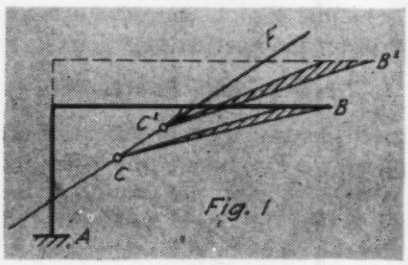


Fig. 1

Referring to Fig. 1, having found the force F required to move C^1 to C and, consequently, B^1 to B, the reaction moment at B equals force F multiplied by its normal distance from B.

For convenience, components of F are used parallel to the axes of a system of right-angled coordinates, the positive directions of which are opposite to the anticipated expansions. These components, designated by X and Y, are obtained from the following equations:

$$+X \cdot I_x - Y \cdot I_{xy} = \Delta x \cdot EI$$
$$-X \cdot I_{xy} + Y \cdot I_y = \Delta y \cdot EI$$

The coefficients I_x, I_y, and I_{xy} designate, respectively, the moments of inertia and the product of inertia of the line diagram about the axes whose origin is at C.

For proof and formulas for the line inertias, the author refers to his book, Piping Stress Calculations Simplified (McGraw-Hill Book Co.)

In the application in Fig. 2 of the method to a single-plane Z-bend, calculate first the flexibility constant K and the modified length of the quarter bends, in order to account for the added flexibility due to pipe flattening in its curved portions. To determine the line inertias, use the modified length (9.3 ft) in determining the position of the centroid, and the special formulas at the foot of the tabulation.

THERE ARE numerous methods of analyzing the flexibility of piping systems and a great amount of material on this important subject has been published. In the June HPAC, Sabin Crocker and Arthur McCutchan reviewed the various methods, and suggested that the advocates of the different schemes each briefly outline the merits of his method and show the solution of two problems; in this way, the reader can judge for himself the suitability of the different calculation procedures in his own piping work. . . . Mr. Spielvogel follows this suggestion in the present article, explaining the essentials of the elastic center method and solving the two problems presented by Messrs. Crocker and McCutchan by means of it. Articles on other procedures will appear in coming months.

To solve three-dimensional problems by the elastic center method, the line is projected successively into the three planes of a right-angled coordinate system. Each projection is then treated as a single plane system with modifications to account for the effect of the members which are outside the plane of projection. The axes are chosen in directions opposite to the anticipated expansions and, therefore, coincide with the direction of the reacting forces at that end to which the centroid is assumed to be connected.

The three projections furnish two moments of inertia about each axis. Their respective sums are I_x, I_y, and I_z. The products of inertia for each plane are I_{xy}, I_{xz}, and I_{yz}.

The unknowns X, Y, and Z are obtained from the three equations which follow:

$$\begin{aligned} XI_x - YI_{xy} - ZI_{xz} &= \Delta xEI \\ -XI_{xy} + YI_y - ZI_{yz} &= \Delta yEI \\ -XI_{xz} - YI_{yz} + ZI_z &= \Delta zEI \end{aligned}$$

The modifications referred to above are applied in the following manner:

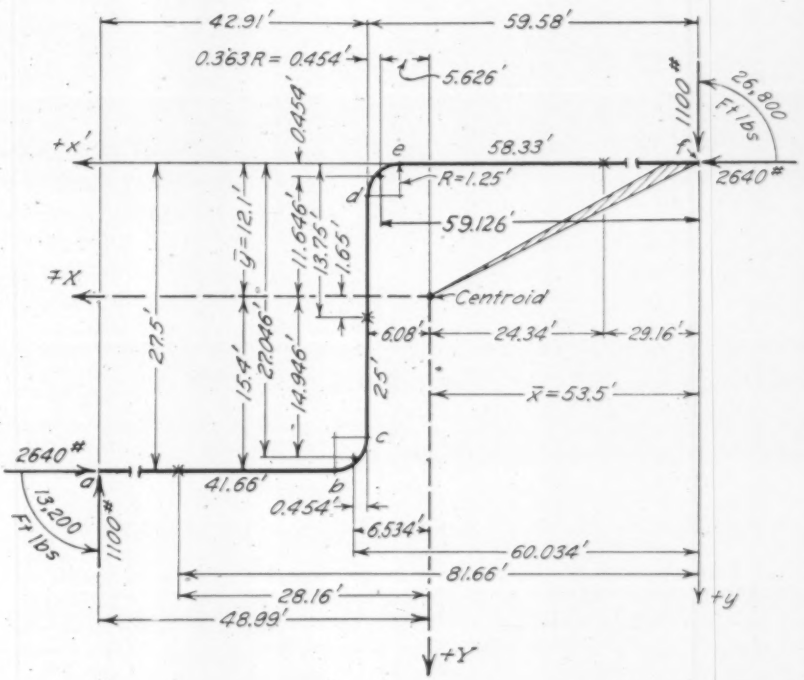
Straight branches situated at right angle to the plane of projection and, therefore, appearing as a point, are subjected to torsion by the forces located in the plane of projection. The torsional effect is accounted for by multiplying the length of such member by 1.3. This constant converts the torsional modulus of rigidity into an equivalent modulus of elasticity.

Curved branches at right angle to the plane of projection appear as a line (dotted). Their torsional effect is accounted for by multiplying the length of the arc by the factor 1.15.

For convenience and orderly procedure, sketches of the pipe line projected into the three planes and the corresponding computations relating to these planes are done in three vertical rows, as shown in Fig. 3. The formulas for the line inertias are listed at the bottom of each row. (For clarification, if necessary, refer to the author's book previously mentioned.)

The numerical solution given in Fig. 3 applies to Hovgaard's three-dimensional pipe bend, shown in the ASME Transactions, Vol. 57, No. 7, October 1935, p. 413.

Fig. 2 — Z-Bend with Welding Elbows



10" Pipe 0.593" Wall $I = 244.8$ in.^{4}
$\Delta x = 6.03$" $\Delta y = 1.62$" $E = 25{,}000{,}000$ psi
Flexibility Constant $K = 4.73$
Modified Length of Quarter Bend $= \frac{\pi}{2}RK = 9.3'$

Position of Centroid

Member	Length, l, Feet	x'	lx'	y'	ly'
ab	41.66	81.66	3395	27.5	1140
bc	9.3	60.03	557	27.04	251
cd	25	59.58	1488	13.75	344
de	9.3	59.12	550	0.45	4
ef	58.33	29.16	1696	0	0
	143.59		7686		1739

$$\bar{x} = \frac{7686}{143.59} = 53.5' \qquad \bar{y} = \frac{1739}{143.59} = 12.1'$$

Line Inertias

	I_{xy}	I_x	I_y
ab	$41.66 \times 28.16 \times 15.4 = 18{,}050$	$41.66 \times 15.4^2 = 9{,}880$	$\frac{41.66^3}{12} + 41.66 \times 28.16^2 = 38{,}900$
bc	* $= 905$	** $= 2{,}070$	** $= 397$
cd	$25 \times 6.08 \times 1.65 = 251$	$\frac{25^3}{12} + 25 \times 1.65^2 = 1{,}368$	$25 \times 6.08^2 = 922$
de	* $= -608$	** $= 1{,}258$	** $= 298$
ef	$58.33(-24.34)(-12.1) = 17{,}150$	$58.33 \times 12.1^2 = 8{,}550$	$\frac{58.33^3}{12} + 58.33 \times 24.3^2 = 51{,}000$
	$I_{xy} = +35{,}748$	$I_x = 23{,}126$	$I_y = 91{,}517$

* $I_{xy} = [0.137R^3 + R\frac{\pi}{2}m \cdot n]K$ ** $I = [0.1488R^3 + R\frac{\pi}{2}m^2]K$

m, n are the coordinates of the centroid of the quarter bend.

$\Delta xEI = 6.03'' \times 25{,}000{,}000 \times 244.8 \times \frac{1}{1728} = 21{,}350{,}000$

$\Delta yEI = 1.62'' \times 25{,}000{,}000 \times 244.8 \times \frac{1}{1728} = 5{,}740{,}000$

$$\left.\begin{aligned} 23{,}126X - 35{,}748Y &= 21{,}350{,}000 \\ -35{,}748X + 91{,}517Y &= 5{,}740{,}000 \end{aligned}\right\} \begin{aligned} X &= 2{,}640\text{\#} \\ Y &= 1{,}100\text{\#} \end{aligned}$$

Reacting Moment at "f" $= +2640\text{\#} \times 12.1' - 1100\text{\#} \times 53.5' = -26{,}800$ Ft lbs

Reacting Moment at "a" $= -(-2640\text{\#} \times 15.4' + 1100\text{\#} \times 48.99') = -13{,}200$ Ft lbs

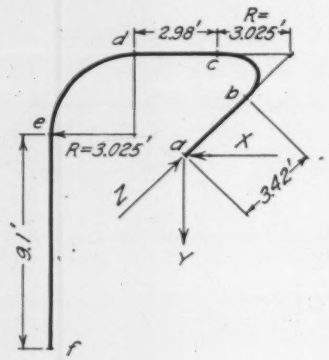


Fig. 3

Pipe : 7.288" OD, 0.241" Wall $I = 33.14$ in.^{4} $K = 2.29$

$E = 24{,}000{,}000$ psi

$\Delta x = 0.66''$

$\Delta y = 0.88''$

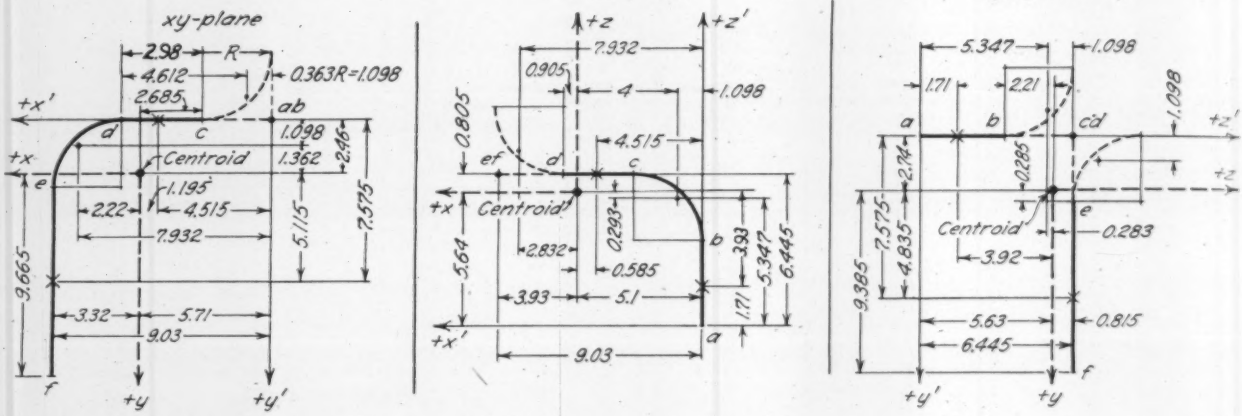
$\Delta z = 0.47''$

$\Delta xEI = 0.66'' \times 24 \times 10^6 \times 33.14 = 524 \times 10^6$ lbs in.^{2} $= 304{,}000$ lbs ft^2

$\Delta yEI = 0.88'' \times 24 \times 10^6 \times 33.14 = 699 \times 10^6$ lbs in.^{2} $= 406{,}000$ lbs ft^2

$\Delta zEI = 0.47'' \times 24 \times 10^6 \times 33.14 = 373 \times 10^6$ lbs in.^{2} $= 217{,}000$ lbs ft^2

PROJECTION



CENTROID

	l in Feet	x'	lx'	y'	ly'
ab	$1.3 \times 3.42 = 4.446$	0	0	0	0
bc	$\frac{R\pi}{2} \times 1.15 = 5.461$	1.098	6	0	0
cd	2.98	4.515	13.5	0	0
de	$\frac{\pi}{2} RK = 10.876$	7.932	86.3	1.098	11.9
ef	9.1	9.03	82.1	7.575	68.9
	32.863		187.9		80.8

$\bar{x} = \frac{187.9}{32.8} = 5.71'$ $\quad \bar{y} = \frac{80.8}{32.8} = 2.46'$

	l in Feet	x'	lx'	z'	lz'
ab	3.42	0	0	1.71	5.8
bc	$\frac{R\pi}{2} K = 10.87$	1.098	11.9	5.347	58.2
cd	2.98	4.515	13.5	6.445	19.2
de	$\frac{R\pi}{2} \times 1.15 = 5.46$	7.932	43.3	6.445	35.2
ef	$1.3 \times 9.1 = 11.83$	9.03	106.8	6.445	76.2
	34.56		175.5		194.6

$\bar{x} = \frac{175.5}{34.56} = 5.1'$ $\quad \bar{z} = \frac{194.6}{34.56} = 5.64'$

	l in Feet	y'	ly'	z'	lz'
ab	3.42	0	0	1.71	5.8
bc	$\frac{R\pi}{2} \times 1.15 = 5.461$	0	0	5.347	29.2
cd	$1.3 \times 2.98 = 3.874$	0	0	6.445	25.0
de	$\frac{R\pi}{2} \times 1.15 = 5.461$	1.098	6	6.445	35.2
ef	9.1	7.575	68.9	6.445	58.6
	27.316		74.9		153.8

$\bar{y} = \frac{74.9}{27.316} = 2.74'$ $\quad \bar{z} = \frac{153.8}{27.316} = 5.63'$

	I_{xy}	
ab	$4.446(-5.71)(-2.46)$	$= 62.4$
bc	①	$= 62.0$
cd	$2.98(-1.195)(-2.46)$	$= 8.7$
de	②	$= -24.2$
ef	$9.1 \times 3.32 \times 5.115$	$= 154.2$
		$I_{xy} = +263.1$

	I_{xz}	
ab	$3.42(-5.1)(-3.93)$	$= 68.5$
bc	②	$= 20.1$
cd	$2.98(-0.585)\,0.805$	$= -1.4$
de	④	$= 12.4$
ef	$11.83 \times 3.93 \times 0.805$	$= 37.4$
		$I_{xz} = +137.0$

	I_{yz}	
ab	$3.42(-2.74)(-3.92)$	$= 36.75$
bc	⑤	$= 4.24$
cd	$3.874(-2.74)\,0.815$	$= -8.64$
de	⑥	$= -7.3$
ef	$9.1 \times 4.835 \times 0.815$	$= 35.8$
		$I_{yz} = +60.85$

		I_x and I_y	
I_x	ab	4.446×2.46^2	$= 27$
	bc	5.461×2.46^2	$= 33$
	cd	2.98×2.46^2	$= 18$
	de	③	$= 30$
	ef	$\frac{9.1^3}{12} + 9.1 \times 5.115^2$	$= 300$
			$I_x = 408$

		I_x and I_z	
I_x	ab	$\frac{3.42^3}{12} + 3.42 \times 3.93^2$	$= 56$
	bc	③	$= 10.3$
	cd	2.98×0.805^2	$= 1.9$
	de	5.46×0.805^2	$= 3.5$
	ef	11.83×0.805^2	$= 7.6$
			$I_x = 79.3$

		I_y and I_z	
I_y	ab	$\frac{3.42^3}{12} + 3.42 \times 3.92^2$	$= 56$
	bc	③	$= 5.2$
	cd	3.874×0.815^2	$= 2.6$
	de	5.461×0.815^2	$= 3.6$
	ef	9.1×0.815^2	$= 6$
			$I_y = 73.4$

I_x and I_y				I_x and I_z				I_y and I_z			
I_y	ab	4.446×5.71^2	= 145	I_z	ab	3.42×5.1^2	= 89	I_z	ab	3.42×2.74^2	= 25.7
	bc	⑦	= 120		bc	③	= 183		bc	5.461×2.74^2	= 41
	cd	$\frac{2.98^3}{12} + 2.98 \times 1.195^2$	= 6		cd	$\frac{2.98^3}{12} + 2.98 \times 0.585^2$	= 3		cd	3.874×2.74^2	= 29
	de	③	= 63		de	⑦	= 48		de	⑦	= 19.4
	ef	9.1×3.32^2	= 100		ef	11.83×3.93^2	= 183		ef	$\frac{9.1^3}{12} + 9.1 \times 4.835^2$	= 274.8
			I_y = 434				I_z = 506				I_z = 389.9

① $= -aR[K\frac{\pi}{2} + R]1.15$
$a = -2.46 \quad K = 2.685$

② $= [0.137R^3 + R\frac{\pi}{2}mn]K$
$m = 2.22 \quad n = -1.362$

③ $= [0.1488R^3 + R\frac{\pi}{2}m^2]K$
$m = 1.36$ for I_x
$m = 2.22$ for I_y

⑦ $= [0.1488R^3 + R\frac{\pi}{2}m^2]1.15$
$m = 4.612$

Formula ② $m = -0.293 \quad n = -4$

Formula ④ $= aR[K\frac{\pi}{2} + R]1.15$
$a = 0.805 \quad K = 0.905$

Formula ③ $m = 0.293$ for I
$m = 4$ for I_z

⑦ $m = 2.832$

⑤ $= -aR[K\frac{\pi}{2} - R]1.15$
$a = -2.74 \quad K = 2.21$

⑥ $= aR[K\frac{\pi}{2} - R]1.15$
$a = 0.815 \quad K = 0.285$

③ $m = 0.283$

⑦ $m = 1.642$

Sum of $I_x = 408 + 79 = 487$
Sum of $I_y = 434 + 73 = 507$
Sum of $I_z = 506 + 390 = 896$

$$\begin{aligned} 487X - 263Y - 137Z &= 304{,}000 \\ -263X + 507Y - 61Z &= 406{,}000 \\ -137X - 61Y + 896Z &= 217{,}000 \end{aligned}$$

$X = 1777$ lbs. $\quad Y = 1796$ lbs. $\quad Z = 638$ lbs.

Reacting Moments at "f"	Ft lbs	in lbs	Hovgaard's in lbs
XY-plane : $-(-1777^{\#} \times 9.665' + 1796^{\#} \times 3.32') =$	1,180	134000	135,400
XZ-plane : $-(1777^{\#} \times 0.805' - 638^{\#} \times 3.93') =$	1080	13000	13,800
YZ-plane : $-(-1796^{\#} \times 0.815' + 638^{\#} \times 9.385') =$	−4518	−54200	54,400

Note: The constants at the right side of the equations differ slightly from those used by Hovgaard, which account for the small difference in the intensities of the forces.

QUESTION OF THE MONTH—

(*Concluded from page 77*)

the latent heat of evaporation at atmospheric pressure and 26.8 cu ft is the volume of 1 lb of steam at atmospheric pressure.

If the weight of the condensate per unit of time and its temperature and pressure are known, it is possible to compute the size of a flash tank, but this volume of hot water generally is not known.

Possibly an acceptable rule would be to use as a flash tank a drum 3 ft long, of the same diameter as the steam main that the tank is to serve. The flash tank generally should not be insulated.

If the tank is to be located in an unusually warm room, its size could be increased. The heat escaping from a flash tank might cause a small interior room to be too warm.

There are published ratings for float traps used to drain high pressure steam mains. It is possible to compute the surface area of the flash tank accompanying such a trap from the pounds of water per unit of time that may be expected via the trap discharge. The surface of the flash tank necessary to release the required amount of heat could be computed by considering it as a steam radiator in thermally circulating air.—S. L.

USE TANK OR TANKLESS TYPE OF WATER HEATER?

YOU ARE *invited to submit an answer to the following question from R. A. about water heaters for publication in these pages. Suitable answers will be paid for at regular rates, with additional payment for sketches. You are invited, too, to submit a question about heating, piping, or air conditioning for publication here.*

I have been told that in hard water areas there is more likelihood of encountering trouble with a tankless type of water heater than there is with a tank type. It doesn't seem to me that there should be any particular difference between the two types on account of water hardness, but I'd be interested in learning of any experience on this point or having comments from other readers of HPAC giving their ideas.—R. A.

SAM LEWIS' PAGE

IN THIS regular feature, informal comment on heating, piping, and air conditioning matters is given by Samuel R. Lewis, consulting mechanical engineer, a member of HPAC's board of consulting and contributing editors. This month he describes a recent inspection of the piping services on a college campus and tells what is wrong with them. This piping is being modernized, and some general rules to be observed in designing and installing the piping distribution system for such central station heating projects are given here.

Well-Planned PIPE TUNNELS Aid Efficient Central Plant Heating

Consulting Engineer Tells What to Avoid

A COLLEGE campus that was inspected recently has a fairly acceptable boiler plant, with mechanical firing. Transmission of piping services to the many buildings scattered over a large area is via masonry trenches. One might call them tunnels (the popular name), though of course they are ducts that were built into ditches that later were backfilled.

The original designer of this rather old plant went all out for central distribution and placed in these long ducts the following services:

1) 8 in. low pressure steam, 5 psi;
2) 4 in. boiler pressure steam, 125 psi;
3) 3 in. domestic hot water;
4) 1-½ in. domestic hot water recirculation;
5) 3 in. vacuum suction return;
6) 2-½in. return from remote condensate or vacuum pumps, 20 psi;
7) 1-½ in. high pressure steam drain;
8) 4 in. cold water;
9) four-channel electric conduit duct;
10) electric light conduit for trench illumination.

The duct is 5 ft wide and 6 ft 6 in. high—stated to be the inflexible "standard" of the college administration office. The duct has occasional drainage traps to an outside sewer. The various pipes are supported on ring hangers from transverse structural steel bars between posts and one wall of the duct. The supports are about 10 ft apart. Many of the pipes are suspended from earlier, higher pipes. Long ago the electric cables became so hot and were so damp that they were superseded by new ducts buried in the ground outside the "pipe tunnel" ducts.

Many of the electric light conduits close to the ceiling are short-circuited due to the heat having destroyed the insulation. Occasionally there is an expansion joint that spouts steam and drips hot water. With so many pipes in so small a duct, all on one side, some of the mains are inaccessible for manipulation of a pipe wrench or welding torch.

The cold water main is, of course, wet and rust covered due to continued condensation on its exterior, and, as a result of the heat, the drinking water in the buildings must be refrigerated locally even in cold weather.

Maze of Branch Mains

Wherever there is a branch connection the maze of branch mains that must pass each other and that must dodge over or under the through mains, involves an interesting crawl for the unfortunate human who traverses the pipeway. He comes to a dark spot and touches the electric light to see why it isn't working, and—standing in the water on the floor—achieves a snappy electronic demonstration. The average temperature in the trench is over 100 deg. Occasionally there is a building (often not of fire resisting construction) through which the mains escape from the duct and spread out in the basement, eventually gathering to enter another pipeway and pass on to other buildings.

It is practically impossible to repack a slip type expansion joint in the duct, or to seal a leak in any main except when the main happens to be the one nearest the alleged working space. As a result, there are several leaks of water, air, and steam that evidently are of long duration.

Obvious Conclusions

Some rules covering general practice may be drawn from this inspection:

a) The pipeway should be wide enough to permit all mains to be stacked but one tier wide, with enough room to operate wrenches on

the largest pipe and with clearance between the pipes and the back wall to reach all flange bolts.

b) No cold water pipes should be placed inside heating ducts.

c) No electric conduits should be placed inside pipeways used for heating except when thoroughly protected and carrying low voltage with moisture-resisting fixtures used only for local illumination.

d) The duct should be high enough for reasonable human progress, with enlarged zones to permit crossover where branches are taken off.

e) Drainage outlets should be frequent, to sewers outside of and below the trenches, with the duct floor pitched to drain readily to the outlet traps.

f) Trouble frequently is found with the tops of these ducts since the inside of a concrete slab will be very warm, while the outside of this slab may be subjected to extreme cold. The expansion and contraction strains permit leakage of ground water into the pipeway. Ducts having a reinforced concrete structural cover, then a composition roof, then a second layer of concrete which often may be a sidewalk, have endured well.

In this specific installation the extreme centralization by the original designer is to be abandoned. The low pressure steam mains no longer are to be employed.

The electric generator engines have been operated only during eight hours per day in winter, since public service energy is available and is proved to cost less than does the extra fuel and labor for operating a relatively small plant 24 hr per day the year around. Thus the 8 in. steam main and the 8 in. vacuum suction return will be removed.

The 4 in. cold water main will be superseded by a new cast iron cold water main, buried outside the duct. The domestic hot water for each building will be heated by steam within each building, and the dormitories where food is prepared will each have two temperatures of hot water—one for dishwashing and laundry, and one, much less hot, for lavatory and bath purposes. Thus there will remain in the old duct only a high pressure steam main, a return from the drainage traps in this main, a condensate return pipe under about 20 psi pressure from outlying electric vacuum pumps, and a new electric conduit for illuminating the passageway.

There will be a new branch from the main pipeway to each separate building, and all services through

Practical pointers on underground piping for institutions and industry are given in this article

the buildings themselves now employed to reach other buildings will be removed. Thus we can enjoy a fire or can wreck an ancient building without putting other buildings out of service.

Larger Ducts Will Be Used

All branch ducts will have enlarged zones at the junctions with the main thoroughfare so as to permit orderly connections with the main lines and new ducts or tunnels will be at least 8 ft wide and 7 ft 6 in. high. In some cases the new passages will be 10 ft wide to permit bad weather travel for pupils and faculty from building to building.

I know of but one college campus where true tunnels are employed for conveying the central heating mains. At the University of Minnesota there is a layer of chalk-like soft rock about 40 ft down, below a stratum of hard rock. True tunneling here is easy and is resorted to extensively. When a new building is built they dig a well down to intercept the soft rock and extend the tunnel to meet it. There should be very few drainage or transmission loss troubles in this great plant.

MIT TO STUDY CORROSION

Corrosion of metals, cause of one of the world's greatest economic losses, will be studied in a coordinated program of instruction and research at the Massachusetts Institute of Technology, it was announced last month with the appointment of Dr. Herbert H. Uhlig to the department of metallurgy to take charge of the project.

In order to consolidate the attack on this major problem, which—it has been estimated—causes losses amounting to several billion dollars annually, Dr. Uhlig will cooperate closely with all departments of the institute concerned with corrosion. The subject has been under investigation at MIT for many years and important work has been done by the departments of metallurgy, chemical engineering, and chemistry. Organization of the corrosion program as a project on which the resources of all departments will be brought to bear is expected to expedite the search for methods of preventing or controlling corrosion. In the oil industry alone it is conservatively estimated that losses from corrosion amount to approximately $125,000,000 a year in refineries and $50,000,000 in pipe lines.

By RALPH MARTIN McGRATH

JOB EVALUATION and the Heating, Ventilating, and Air Conditioning Engineer

THE job evaluation engineer and the heating, ventilating, and air conditioning engineer meet at the most sensitive spot in the entire production area—the workman's bench. Here the directives of top management become effective, because it is the point at which the human element and the material element blend to form the chain of events known as the manufacturing process. It is at this point that all of the engineering skill of industry is focused. Here will be found the planning engineer, the management engineer, the safety engineer, the hazards engineer, the medical staff, the heating, ventilating, and air conditioning engineer, and the job evaluation engineer—all with the purpose of producing the best product at the lowest practical cost. Each of them is interested in the workman and his bench. It is primarily of the job evaluation engineer and the heating, ventilating, and air conditioning engineer that this article deals because, up to the present time, the relationship between these two has not been well understood.

The heating, ventilating, and air conditioning engineer is interested in the working conditions under which the work is done; so is the job evaluation engineer, but for a different purpose. The heating, ventilating, and air conditioning engineer is interested in *controlling* the elements in the working conditions that interfere with production, while the job evaluation engineer is interested in the *appraisal* of the final result. The job evaluation engineer is not interested primarily in changing those working conditions, for his is the job of judging the conditions as he finds them; but the heating, ventilating, and air conditioning engineer *is* interested in changing those elements—because, as the degree of annoyance is reduced in this environment, worker morale and production rise. To the extent that the heating, ventilating, and air conditioning engineer is successful in reducing the degree of discomfort of the job to the worker, to that extent does he affect the ultimate evaluation placed upon the job by the job evaluation engineer.

In his search for methods of reducing the annoyance factors in the workman's environment, the heating, ventilating, and air conditioning engineer has developed a series of objective standards that are at the disposal of the job evaluation engineer if he wishes to use them. The fact that few job evaluation engineers have used them is deplorable and stems from the fact that objective criteria have not been established by this profession for the use of its engineers. At the present stage in job evaluation engineering much of the judgment is based upon the opinion of so-called "experts" and it is the thesis of this article that it need not be any longer. There are objective data upon which the opinions of the job evaluation engineers can be based and those data have been developed by the pure sciences and applied by the heating, ventilating, and air conditioning engineers to the solution of their particular problems. There is no real reason why these same data cannot be used by the job evaluation engineer in solving his problems.

"Degree of Disagreeableness"

There has been so little published upon how the job evaluation engineer goes about making his evaluation that it is the bold spirit who

THE JOB evaluation engineer and the heating, ventilating, and air conditioning engineer meet at "the most sensitive spot" in the entire production area—the worker's bench, where the former must appraise working conditions and the latter is interested in controlling them. . . . In this easy-to-read article, Mr. McGrath (himself a job evaluation engineer) explains some of the factors that must be known to evaluate a production job, discusses the data on atmospheric and other conditions he must have to do so, and stresses the importance of job evaluation and heating, ventilating, and air conditioning engineers working in close harmony.

ventures to discuss so virgin a field in a publication devoted to the interests of heating, ventilating, and air conditioning engineers. Enough has been published to enable us to point out that the base line usually employed is that of the "degree of disagreeableness'" of the worker's environment to the worker. In the composite called "the worker's environment" may be recognized three elements which the author classifies as major in importance—noise, heat and humidity, and fumes and dust—and two minor elements—oil and grease, and the kind of protective clothing which must be worn. It is admitted that there are other base lines which may be employed but the most logical one is that of the degree of comfort or lack of comfort that the presence of these major and minor elements causes to the man on the job.

Two of the most widely adopted job evaluation plans recognize five degrees of discomfort but neither of them sets up the objective standards by which they are to be differentiated. The problem of the engineer is to establish the points at which each of the five levels begins. It is perhaps more accurate to speak of the location of the *bands* of discomfort rather than of *points*. Since the plan makers did not set these levels up, the engineer must do so. The differences of opinion among job evaluation engineers on where these bands lay led the author to make a study of the possibility of setting up objective standards and he is convinced that it can be done.

What Data Are Available?

In establishing the levels of disagreeableness of noise, the work of the acoustics engineer is available and his publications indicate that two units of measurement may be employed: the decibel and the frequency.

In establishing the levels of heat and humidity, there is the extremely valuable work of the American Society of Heating and Ventilating Engineers, which has been studying the problem of how to make the workman's environment more comfortable for a long time. The ASHVE has given us the "effective temperature" and the zones of comfort.

In establishing the levels of discomfort from fumes and dust, there is the work of the industrial hygienists and the safety engineers who have developed the data upon the "concentration in terms of the number of parts of the element to the million parts of air." These are objective units of measurement and there is no reason the job evaluation engineer should not use them and the data developed by these engineers.

Levels of Disagreeableness

The exact point in the continuum of disagreeableness at which each of these levels shall be established is a function of top management acting upon the recommendation of the job evaluation engineers, since any evaluation in any of the attributes ultimately affects the price that is paid for the job.

It is the personal opinion of the author that care must be exercised to keep the scale of disagreeableness within the limits marked by the injury to health level. It should be obvious that serious repercussions would result from the fixing of the fifth degree at the level where exposure to the elements used in evaluating working conditions was injurious to the health of the worker. It is almost imperative, then, that the engineer recommend no scales for the consideration of top management that say in effect "the working conditions of this degree are so disagreeable as to affect the health of the worker to the extent that they injure his health." This is the basic argument upon which the author rests his urgence that the attributes "working conditions" and "unavoidable hazards" be scaled on different base lines. The base line developed by the heating, ventilating, and air conditioning engineers—that of the comfort of the worker—seems not only the most logical one but the safest one from every angle. To the industrial hygienists and the medical staffs belong the development of the bases for the evaluation of the attribute "unavoidable hazards."

The following are suggested as the points at which these bands should be established and are based upon a review of the present available studies in print. They are offered in the hope that they will stimulate other engineers to assist in helping to delimit them with greater accuracy than the present information makes possible.

NOISE

The fifth degree: the beginning of the established hazards level. Note: this is not the level at which sound intensities cause pain.

Fourth degree: the beginning of the danger zone.

Third degree: the beginning of the zone in which noise levels are reported as annoying to all of the normal population of workers in the job.

Second degree: the level at which 50 per cent of the normal population of workers report the noise as being annoying.

First degree: the level at which none of the workers report the noise element as disagreeable.

(In the field of "noise" the subjective judgment of the individual is not a wholly reliable index because of the fact that the worker can report an adjustment to the noise even while hearing injury is proceeding of which he is unaware.)

HEAT AND HUMIDITY

Fifth degree: the beginning of the danger zone.

Fourth degree: the approach to the danger zone.

Third degree: the upper limit of the comfort zone of men normally clothed and actively at work.

Second degree: the point at which 50 per cent of the workers report the level uncomfortable.

First degree: the point at which all of the workers report the conditions as being comfortable.

The base line: men actively at work in factory jobs and normally clothed for sustained periods that represent conditions comparable to the typical eight-hour day.

(Unlike "noise," the human organism has not yet developed a means of adaptation that is as deceptive as that for "noise." Here, too, there is

Job evaluation is the objective appraisal of the human factors required by the job, viewed from the position of the job itself

a need for the establishment of the zones upon objective data of comfort rather than subjective data or purely individual reports.)

FUMES AND DUST

Fifth degree: the unsafe zone.

Fourth degree: the point at which the concentration produces "toxic" reactions.

Third degree: the point at which the concentration produces "disagreeable" reactions.

Second degree: the point at which the concentration is merely annoying.

The first degree: comfortable: (no manifestations of annoyance).

It is recognized that whenever any environmental condition is reported as being disagreeable to the living organism it means that defensive and protective reactions are in action. The real bases even for the "disagreeableness" base line are physiological and psychological data indicating the extent to which these defensive and protective reactions are in action. Attention is invited to the fact that specific data are not given for each of the degree levels mentioned above and the reason for omission is that additional research is needed in the field of noise and dust to delimit them before they are made final. In the field of heat and humidity the author believes that the research of the heating, ventilating, and air conditioning engineers has been so carefully done that these levels can be set up, tentatively, so that other engineers may initiate work that will either confirm them or move them.

In the field of *noise* there is an urgent need for the publication of both decibel levels and frequency levels of each of the kinds of machines used in production: punch presses, power brakes, drill presses, screw machines, milling machines, lapping machines, welding machines, heading machines, threading machines, slotting machines, lathes, insulating machines, braiding machines, boring mills, grinders, coil winding machines, gear cutting machines, gear hobbers, forging machines, planing machines, sheet metal operations, materials handling machines, and a host of others. It is very difficult to get decibel levels and frequency levels on each class of machine that is used in the service and production jobs of modern factories—not because it is so difficult to measure but because when it is measured the results are not released by the measuring engineers. Data are needed, too, on the noise levels in assembly rooms, packing rooms, plating rooms, molding operations rooms, and materials handling locations. Why the decibel levels that have been ascertained by industrial plants have been kept so closely guarded as secrets is hard to understand.

In the *heat and humidity* field there is need for much more accurate data on the five levels mentioned above for men actively engaged at work at factory positions normally clothed for the typical working day. It is of little use to offer to representatives of top management experimental evidence drawn from laboratory conditions that are so remotely comparable as many of the studies now available. Valuable as the studies now reported are, most of them are still not on the comparable basis. From the results we may infer broad general principles but until the experimental studies conform more closely to the actual job conditions of the factory they will remain informative but not directly comparable. Studies are needed for periods of eight hours a day and extending from three to six months.

In the *fumes and dust* field there is need for more published reports on the concentrations that are annoying, disagreeable, toxic, and unsafe. The literature indicates that there is a greater amount of data in existence than has been published. What is needed is the publication of the data.

Need For Standards

There is a need for the establishment of a national committee on *job evaluation standards* with a view to developing standards that will have the force and respect of those now being promulgated by the American Standards Association. The ultimate of this committee's work should be the formulation of standards that can be recommended for adoption by the ASA for the guidance of engineers throughout the United States.

There is need, too, for the development of a *guide handbook* for the use of job evaluation engineers that will have the prestige and usefulness of the Guide published by the ASHVE. Such a handbook would have in it standards for the evaluating and pricing of the various attributes, from education to unavoidable hazards; it would have comparative job structures based upon the analyses of published wage structures: it would have data on piece rates and incentives. It would have a section devoted to definitions, and a roster of qualified personnel.

There is a need for the formation of *job evaluation engineering societies* in which such engineers can discuss their problems in a free and scientific atmosphere in order that the differences of opinion that now exist among them can be aired and reconciled. There is a need for the admission of the points of view of job evaluation engineers to such columns as "Open for Discussion", appearing in Heating, Piping & Air Conditioning. Heating, ventilating, and air conditioning engineers seem not to be afraid to air their differences of opinion and job evaluation engineers should not be either. The professional field does not need another group of engineers off by themselves talking to themselves; but it does need the inclusion of other points of view such as those that the job evaluation engineers could bring with them.

Scientific Basis

Finally, there is a need for the job evaluation engineering profession to put its own house in order and establish itself upon a truly scientific basis. Among the personality traits not needed by job evaluation engineers at this stage of the science are those of a salesman. Valuable as this ability is, job evaluation needs to perfect the product that it has to sell before it does any more crowing about how good it is. Among the basic traits of the human mind that job evaluation engineers need the least of at this time is the verbal ability.

What Job Evaluation Is

Job evaluation is the objective appraisal of the human factors required by the job, viewed from the position of the job itself. As such, it is a scientific branch of the personnel field and as such it might be called "human engineering"—although the connotation that has grown up around that term has been so emotionally labelled as to make the author wish not to employ it until it can be redefined. Such an engineer does not have to be technically trained in all of the various types of engineering that contribute to the complex process that we know as the manufacturing process, but he must be familiar with the methods of measurement of the human factors that compose the duties which management states is "the job". This means that he must know what educational background is essential for entry upon the duties of the job with normal supervision; what training on the job is needed in addition to the educational background just mentioned; what type of independent judgment is required to perform the job correctly; how to measure the physical demands of the job upon the average worker who fills the job; how to evaluate the mental and physical demands of the job; how to compute the degrees of responsibility; what the nature of the hazards of the job are and the social and legal implications of each of those degrees; and lastly—the subject matter of this article—how to measure and evaluate the elements which compose the working conditions of the job.

Functions of Engineers

The function of the job evaluation engineer is to appraise: of the ventilating, heating, and air conditioning engineer to control the elements of the working conditions. In his appraisal capacity, the job evaluation engineer is a staff officer to top management in that he informs it of the ultimate price that must be paid to get this tour of duties performed. The appraisal of the job evaluation engineer is the opportunity of the heating, ventilating, and air conditioning engineer—and the two types of engineers should work in close harmony.

The Nation's Standard of Living Depends on Construction Industry

Progress in a nation depends upon the pioneering spirit of its people. In this country, we have developed the genius for the transmission of new ideas through research and engineering into new and better products and into new and better services for the people. When this process is continuous, we have good times, active business, and high employment. When for some reason it is interrupted, we have bad times, stagnant business, and low employment.

It is commonplace to say that already we have a high standard of living—the highest in the world. It is high for one reason only and that reason is the high per capita productivity of our people.

And why is this so? It is not the length of the workday. Few work long hours anymore except the farmer and the men who write directives, and especially those who try to interpret them. It is not because of back-breaking toil. Even the farmer has an easy time physically compared with the food producers in other lands.

There is only one reason for the productivity of the American workman, and that is the better tools and skills which have been developed, and most important of all, the power to drive those tools.

Men's muscular power is limited to a small fraction of a horsepower. The industrial age has augmented this power until, as stated by Gwilym Price, president of the Westinghouse corporation, in 1939 every factory worker had between five and six horsepower at his disposal. Note how this has risen. In 1900 it was two horsepower. In 1920, less than three, reaching between five and six in 1939. It is doubtless higher today, but current figures are not available.

If we are to add one more horsepower for every factory workman, it means the construction of two billion dollars worth of power houses and transmission lines. To this must be added the buildings to accommodate the larger units of production with their modern conveniences, such as air conditioning, perhaps doubling the two billions mentioned.

All this means construction and demonstrates again the progressive role of the construction industry in accomplishing the universal purpose of constantly increasing the standard of living of everyone in the nation.—*From an address by E. P. Palmer, president, Senior and Palmer, before the Chamber of Commerce of the United States.*

QUALITY AIR CONDITIONING

(The Part Played by the Consulting Engineer and the Architect)

By Samuel R. Lewis

QUALITY AIR conditioning was the theme of a symposium at the recent spring meeting of the American Society of Refrigerating Engineers at St. Paul. Mr. Lewis, consulting mechanical engineer and a member of HPAC's board of consulting and contributing editors, prepared this article for the symposium, in which he outlines the part played by the consulting engineer and the architect in assuring "quality" installations. His remarks comprise a practical check list of things to do and things not to do if a comfort air conditioning installation using refrigerated air is to give full satisfaction. He lists briefly six jobs that gave trouble.

IN discussing the part to be played by the consulting engineer and the architect in assuring quality air conditioning, I have no license to speak for the architect. Therefore, I can only record what I continually tell the architect; sometimes the architect cooperates.

Presumably, "quality" means *first* quality and "air conditioning" means use of refrigerated air. The easiest plant to design is one for which the construction of the building is arranged for the maximum resistance to heat transfer and in which adequate clearances are provided for the apparatuses and for the ducts and pipes that must serve them. Whether the building or enclosure to be served is in existence or whether it is new, has a potent influence on the quality of the results that can be expected. Specifications of the ideal conditions that always are to be hoped for, vary considerably under the influence of the character of occupancy and size of installation. There are many differences between an industrial processing air conditioning installation and one for promoting human comfort.

My remarks refer to comfort installations and they are all based on specific recent experiences in correcting unfortunately designed existing plants or in the light of observations of more fortunately designed existing plants.

Granted a comfort installation in a large office of an industrial plant, the architect might be urged to set aside for the machine room an area near the center of the space that is to be served, so that any air distributing duct need carry not more than half the volume of air it would have to transport if the machinery room were at an end of a long building.

Deliver Cooled Air Downward

The machine room could very well be in the next story above the space to be served.

We might suggest that cooled air is more easily delivered downward to the horizontal ducts than forced upward to them, and that this virtue overbalances the resistance encountered when forcing warm air downward.

We would endeavor, in the northern hemisphere, to obtain the supply of outside air through an opening in a north wall rather than from directly above a sun heated, black surfaced roof, or from either the east or the west sides of the building.

Protest would be made against any attempt to design a plant for use only in summer. If ventilation and comfort are desirable in summer they are even more desirable in the spring and fall and on cold winter days.

Positive Fan Exhaust

There would be positive exhaust by a fan, capable of delivering all the air removed from the rooms by it, either outside or back to the intake of the supply system. The proportion of recirculation to the total volume of air supplied would be variable and adjustable. Thus, in extremely hot or extremely cold weather the percentage of recirculation prior to occupancy would be high, and during occupancy it might be sufficient only to control odors or to comply with health department rules. On spring and fall days when the outside air is cool enough to avoid operation of the refrigerating plant, 100 per cent outside air would be enjoyed and 100 per cent of the spent air would be wasted outdoors.

Arrangements would be made for filtering both recirculated and outside air.

The design of the ducts for distribution of the air throughout each story would be dictated by the location of the partitions, or if there are great open spaces

there would be at least one inlet for every construction bay or one inlet for a minimum of each 400 sq ft of floor area. Considerable effort would be made to secure in each room or bay a commensurate spent air opening for every air supply opening, though if these could not be obtained reasonably for every bay, recognition would be made of the fact that delivery of the air supply to the critical area is more important than minute distribution of the air removal.

Individual Automatic Temperature Control

Every private office would have means for individual automatic temperature control. There would be emphasis on the possibility that at some future time partitions may be added or moved, and that intensities of occupancy may change. Many "nonquality" air conditioning plants might have been quality ones if zoning for automatic temperature control had been designed for each construction bay or for each private office, rather than zoning for solar influence on the whole east side or west side of a long building.

Air supply inlets designed to introduce air at high velocity at right angles to or even diagonally toward transverse ceiling beams and toward exterior walls should be viewed with alarm. I remember one large installation in which, for many private offices, the air delivery is overhead, horizontally toward the windows. The executives in these offices preferred to sit with their backs close to the windows and they faced the supply inlets. The entering air, especially when cooling the room, caused an objectionable down-draft that could be felt against his back by each man at his desk.

We should go to great lengths to provide large air volume and low air inlet velocity so that, especially when cooling, the heat can be carried away with a small temperature differential between the air in the room and the entering air, and so that the injector effect of the entering air with its tendency to cause counter flow of dust laden room air, will be minimized.

There would be provided the most efficient air filters that money could buy, as nearly automatic concerning rejuvenation as could be found, and visual signals should be installed to aid in maintaining the filters at a high standard.

Don't Be Afraid to Reheat

The engineer should not be afraid to use reheating, even at a slight increase in refrigeration demand, since by reheating the least complicated and longest enduring automatic differentiation of temperature and relative humidity in different rooms or zones can be obtained.

Every air supply intake from outside and every outboard exhaust outlet would have a normally closed, very tight damper that would be open only if the electric circuit to the respective fan motor were closed.

The thermostat in any room or zone would control all of the controllable sources of heat that could affect the thermostat.

There would be provided under every air supply apparatus located above the bottom story of the building, a watertight and positively drained and curbed floor, to prevent the damage that otherwise eventually may occur from leakage of water or steam or oil.

Every piece of live apparatus—such as fans, motors, and pumps—that could induce vibration or noise would be isolated on antivibration bases and consideration would be given to acoustical treatment of the machinery room and of the air ducts.

There would be an airtight access door and an adequate electric light for every compartment in the airway.

Six Jobs That Gave Trouble

The basic reasons for many of the foregoing specifications are the result of the following experiences. The faults outlined have been corrected:

1. A state capitol building in which the air conditioning was installed for summer only. The solons were expected to do without any ventilation in the winter.

2. A bank, with the air conditioning plant above the executives' island, upon which plaster fell, and oil and water leaked down on the tops of the devoted brass hats.

3. A general office several hundred feet long, zoned for east-west orientation, but having north and south ends that eventually were deprived of either cool air or warm air because the controlled delivery temperature for the zone, adjusted to varying solar heat reception, proved rarely to be endurable in the north and south end areas.

4. Another large general office in which the zone control thermostats were located in rooms that had direct radiators having only manual control. As the radiator heated the thermostat that controlled the zone temperature, cooler and cooler air was delivered to all rooms on the zone, causing cold drafts—especially in the rooms where the manually operated radiator supply valves were closed.

5. A ventilating plant in which, whenever the supply fan was not running, the warm air from the tempering convectors reversed direction and poured through the outside air intake, wasting much fuel and chilling the rooms overnight by reversing the direction of the air flow in the exhaust ducts.

6. A ventilating plant in which the considerable air pressure developed by the air supply fan, in the absence of any exhaust fan, was unable on a summer day to force any appreciable volume of spent air up through six stories of offices. In this case even though as much as 100,000 cfm of air cooled to 60 deg was forced upward through the building by a fan and a 50 hp motor, no measurable amount of air was delivered outboard through the gravity roof ventilators.

QUALITY AIR CONDITIONING

(The Part Played by the Air Conditioning Contractor)

By A. C. Buensod

QUALITY in air conditioning installations means the fulfillment of the desired performance of a coordinated design comprising heating, cooling, dehumidification in summer, humidifying in winter —utilizing, of course, distribution of the treated air—and producing a condition of comfort for the occupants, avoiding any discomfort, and providing stated conditions as dictated by a particular industrial process.

Likewise, quality means the proper selection, coordination, and the control of the needed equipment in order to produce the air conditioning results desired.

Past history in the air conditioning industry indicates that the pioneering work was accomplished by energetic engineers who had the courage and vision to devise and invent the necessary equipment to do the work, and to use their ingenuity in developing new methods of controlling and distributing the treated air to effect what we now term comfort conditions or to maintain rigid atmospheric control of temperature and humidity for certain industrial processes.

This pioneering work required years of effort, as it was in a virgin field and the lack of proper equipment was a serious handicap. Thus manufacturers of equipment in more or less the true sense of the word, who had the shop facilities and the engineering talent to keep progressing from year to year, carried out the early attempts in air conditioning design and installation until standard practices were evolved.

In those pioneering days, there were only a few firms or individuals that had any acquaintance with the problems connected with air conditioning installations. It is, therefore, only natural that in the course of some 40 years a great many engineers and other technicians acquired the valuable experience in experimenting and developing this new industry, and have become real specialists in this field. It was a difficult and laborious task and many hours of labor were utilized in making some of the earlier installations function and in devising new methods and new equipment which were improvements on the equipment available before that time.

Just as an illustration, air conditioning created the demand for a refrigerating system and thus was born the centrifugal type of refrigeration. The cleaning of air became more important and many types of dry filters were devised to better the cleaning efficiency that was obtained in a spray type washer. Automatic controls available today are of staggering importance compared with the very meager and simple thermostats and hygrostats available in the earlier years. The "Freon" group of refrigerants opened up the commercial field in air conditioning, permitting automatic operation of small reciprocating refrigeration compressors.

Contractor Must Coordinate the Design

The air conditioning contractor of today really has to sit up nights studying the various new types of air handling equipment, air distribution outlets, refrigeration systems, automatic control systems, and various other gadgets that make an air conditioning system function. The air conditioning contractor obviously has the contract for an installation and is financially responsible, and, therefore, must be thoroughly conversant with all of the engineering and installation technique to be able to coordinate effectively all the parts of a design so that, when it is completed, it renders the results for which it was planned. These duties are all in addition to the contractor's ordinary responsibility of handling materials and labor, and gambling on what he can do to meet stated costs.

Air conditioning installations are not the simple contracting proposition that a boiler and steam piping project usually turns out to be. If the boiler is the right size, the piping is sized correctly, and the radiators are placed properly with the right amount of surface, many mistakes can take place but you can still heat. This is not true of air conditioning, as a consensus of experienced air conditioning contractors shows that the cost of adjustments, service, mistakes in design and possible replacements averages from two to three per cent of the selling price. If this reserve for service and adjustment is not allowed for, the contractor simply has to dig it out of his pocket, because the best technique now known in the industry will not eliminate this expense.

Most of the pioneering work

has been accomplished notwithstanding the facts that there will always be new and better equipment and that with the great numbers of air conditioning specialists, new systems are bound to be evolved which will be an improvement in the coordination of the equipment now available, or to be made available, and the use of treated air to avoid the absorption of unnecessary heat. Always there is the incentive to maintain desired results at a lower first cost, and a lower operating cost.

It is a great satisfaction to the specialists in the air conditioning industry to realize that the collective effort of all concerned has had public acceptance and that the demand for quality installations has been tremendously increased. It is also a satisfaction to realize that today we have a great many individuals and firms who have become highly skilled in the design of plans and in the preparation of the required specifications for air conditioning projects.

Competent Consultants

The air conditioning contractor fully recognizes the duties and the value of competent air conditioning consultants who formulate the necessary designs which are dictated by an intense study of the client's requirements, assembly of basic load data, and the usual coordination of the design with the architecture, and the client's particular problem of operation.

This does not eliminate the routine work required to determine the electrical load characteristics and proper placement of eletrical services for driving the equipment, the steam heating connections, city water supply, plumbing and drains, as well as proper housing for the air conditioning equipment itself. The consultant obtains his remuneration by carrying out this vital part of the work and in creating a basic design. There are many air conditioning contractors who are fully competent to perform the work usually done by a consulting engineer but unfortunately most clients might expect to obtain this without proper remuneration and it is the opinion of the author that on the larger projects especially, it would be inadvisable on the part of the client to try to eliminate the highly valuable work contributed by a consulting engineer.

It is also quite true that there are some types of projects, especially industrial processes, in which many of the air conditioning contractors have specialized for many years and in which they would be more competent to carry out the owner's requirements, barring always the fact that if there is a new building of any size, the owner must have an architect and should have a consulting engineer. On the smaller types of commercial air conditioning projects, they are really too small for a consultant to be remunerated properly and therefore these types of projects have been handled by highly specialized selling and contracting air conditioning organizations —usually dealers or distributors of large manufacturers of air conditioning equipment.

The air conditioning contracting industry is really a profession like medicine or professional engineering, and it is quite necessary for the air conditioning contractor to specialize in the types of projects in which he is familiar, and avoid the responsibility and financial risks in tackling types of projects for which he is not equipped with the necessary experience.

The author believes this is equally true in consulting air conditioning engineering and it has been his observation that many eminent consulting engineers prefer retaining other engineers who specialize in air conditioning, because the air conditioning experience gained in past projects is most valuable.

Prequalification of Contractors

There has been a marked tendency in the past 10 years, accentuated in the war years, that there should be a prequalification of air conditioning contractors before selection to submit proposals for air conditioning installation work. This tendency was perhaps a normal evolution in the air conditioning industry as it has been well demonstrated that the experience and the "know how" embodied in a contractor's organization is of vital importance in assuring quality.

Performance Guarantees

There still seem to be several ways in which plans and specifications for air conditioning work are prepared.

First, a rigid set of detailed design drawings and clear specifications requiring only the experience and installation facilities to execute the work normally. This type may only have the usual warranty on equipment and workmanship but without any guarantees covering performance.

Second, plans and specifications similar to the first, but rigid performance guarantees are specified.

This, then, of necessity requires the prudent air conditioning contractor to study the given design and the specifications, checking in detail all the computations in order that he might rightfully know the financial risk in accepting such performance guarantees, as *he only* is financially responsible and has to make good on any changes required to bring the performance up to the specifications guarantees. Where such performance guarantees are required, the air conditioning contractor should reserve the right to make such changes in the capacity of equipment, or in the air distribution or other pertinent details

(*Concluded on page* 95)

THE EXPERIENCE and "know how" of the air conditioning contractor has an important bearing on quality air conditioning installations, as outlined and discussed here by Mr. Buensod, who is president of Buensod-Stacey, Inc., a leading contracting firm. In this article—which was prepared for presentation at the air conditioning symposium held during the recent spring meeting of the American Society of Refrigerating Engineers at St. Paul—Mr. Buensod explains the functions of the contractor and his relationship to the consulting engineer, discusses prequalification of contractors and performance guarantees, and concludes by summarizing the steps the contractor must follow to assure quality.

In the waiting room, which is 55 ft long and 20 ft wide, of the C. & O.'s new station at Prince, W. Va., wrought iron radiant heating pipes were installed both in the ceiling and the floor. The ceiling, 17 ft high, is constructed of perforated metal with a 1 in. layer of sound absorbing material. The tar and gravel roof is on 4 in. of concrete topped by 2 in. of foam glass insulation. The 1¼ in. ceiling coils, spaced on 12 in. centers, are suspended from metal hangers behind the ceiling. The floor coils, fabricated of 1 in. pipes on 18 in. centers, are embedded in 1¼ in. of sand on a 4 in. structural concrete floor slab. The sand is covered with concrete, topped by terrazzo

Radiant Heating — Floor, Wall, or Ceiling?

THE EDITOR—I enjoyed reading F. W. Hutchinson's article, Radiant Heating—Floor, Wall, or Ceiling?, in the March HPAC and appreciated how closely his "purely mathematical approach" agreed with test results as well as with practical experience, gained in long years of operation. Since I do not consider it a mere coincidence that England and the European continent install more and more ceiling systems, I would like to express my views on this article, and the discussion on it by C. A. Hawk, Jr., in the April HPAC.

I readily agree with Mr. Hawk that thousands of occupants have failed to see the difference between floor and ceiling installations, even in cases where both kinds of coils are installed in one structure. The human body is too crude an instrument to register immediately small variations in temperature and humidity, such as occur in buildings where ceiling and floor installations are both involved and where—due to the intimate interchange of air and humidity between such rooms—these differences are greatly minimized, if not wiped out altogether.

Also, my individual experiences with occupants of fully ceiling and floor operated systems are much in agreement with those of Mr. Hawk.

However, not only the scientist but also the engineer should be able to advise the individual occupant as to the properties of his heating system rather than to draw his information from this occupant. Being the only one to judge and compare great numbers of radiant heating systems, the engineer should carefully distinguish between their properties and be aware of their influence upon physiological and practical conditions.

Physiological Properties of Ceiling and Floor Systems

In order to base our comparison on certain conditions, let us assume as an "ideal base" the outdoor conditions on a clear and calm spring day. Great comfort is gained from the following properties: (1) Lack of high temperature surfaces; (2) all surfaces, no matter what their composition or location, are of even temperature; (3) no stratification; (4) air is calm (no winds or drafts); (5) due to lack of air motion, little dust is whirled up and suspended in the air; (6) air is heated from the ground, which in turn is heated by radiation from above (sun); (7) mean relative humidity is low; (8) human body receives mild radiation from above.

Properly designed floor and ceiling systems compare equally well and very favorably with the properties (1) to (4) of the "ideal base" or outdoor conditions. In properties (5) to (8) the ceiling system is superior. Let us see why:

(5) The floor system, due to its relatively great convection output, tends to keep in suspension dust particles whirled up by the occupant from the carpet, etc.

(6) Although with floor systems the air is heated from the "ground" (that is, floor), the floor in turn is not heated by radiation from above. Although I don't like to draw differences in heat transmission channels—that is, between convection and radiation—I consider it most important to find that output by radiation in a ceiling heated room is approximately 40 per cent greater than that in a floor-heated room. Thus we should find the air temperature higher in floor systems than in ceiling systems, and the mean surface temperature of the room enclosure (MRT) lower in floor systems than in ceiling systems.

(7) Having higher air temperature, the floor system must have slightly lower relative humidity, but we try to get away from the dry air conditions of heated rooms.

(8) In floor systems the human body obtains no radiation from above. The ceiling system, however, efficiently duplicates (as well as possible) the "ideal standard." The body receives heat by radiation "from above." The air is but little directly heated from above, and rather by "reflected" heat from the "ground" (floor) and the walls. How important this principle, "radiation from above," is in connection with the rather sturdy human body, we do not know. Years of practical experience or experimentation in physiological labs will be required to find a true answer.

But that there are certain influences upon more fragile creatures should be noted. A verbal citation of the U. S. Department of Agriculture reads: "Poultrymen tell us that it (the floor system) is not the correct mode to brood young birds, inasmuch as nature has, through many generations, developed a method of heating chicks through their backs. Too much heat on the floor is likely to cause leg weakness and crippled chicks. On the other hand, a damp and chilly floor is likely to cause trouble also."

The last sentence takes us to the second point of my discussion:

Case A—Floor or foundation not insulated: The loss through such floors cannot be checked. For this reason—with unfavorable ground conditions—floor panels may have heat losses as high as 45 per cent of the entire heat supply, and ceiling panels may result in cold floors. Conclusion: To safeguard against such conditions, provide insulation of the building or the circumference of the floor.

Case B—Insulated building space: Loss of floor panels is minimized; floor temperatures in the ceiling heated room are greater than air temperatures. Reason: The greater part of the ceiling output is dissipated in the form of radiation. This radiation hits the room enclosures, hence the floor—which in turn heats the air. Since the insulated floor cannot lose its heat to the ground, its temperature is greater than the air temperature. Very large buildings on dry ground do not require floor insulation with ceilings or floors heated.

According to general opinion, for physiological comfort, floor temperatures should not exceed 85 F. For structural reasons, floor temperatures should not exceed 95 F. Although temperatures much in excess of 85 may be considered comfortable by some occupants, it is questionable whether they are natural, or even healthy. Floor surface temperatures much in excess of 95 will not damage a concrete structure, but they may soften the mastic cement of linoleum and similar floors and eventually damage wood flooring. They may also embrittle and eventually pulverize the fiber of carpets within a period of five years or more.

With these temperature restrictions in mind, the output of a floor at 85 F mean temperature (its maximum temperature is actually nearer 95 F) in a room heated to 70 F comfort temperature is not greater than 40 Btu per sq ft; at 95 F floor temperature, the output is not greater than 65 Btu per sq ft. These figures rely on actual results found by a great number of engineers in several colleges in the U. S. and abroad and there is no reason why we should abandon such data because of the statement of a great number of occupants that they feel comfortable. Obviously, systems designed for an output appreciably greater than 40 Btu per sq ft operate at surface temperatures higher than 85 F (that is, at cold outside temperatures) which, I believe, is not desirable.

However, if 85 F is considered as a limiting temperature, many buildings cannot be handled by floor systems only. Most corner rooms will call for a heat output greater than 40 Btu per sq ft, unless located in the southern part of the U. S.

I should not like to close this discussion without expressing wholehearted agreement with Professor Hutchinson's article, and I hope that this article and its discussions contribute to a better understanding of the properties of radiant heating systems.—R. G. VANDERWEIL, project engineer, Chase Brass & Copper Co.

WHEN ENGINEERS gather to hear a paper or talk, there comes a time when the meeting is thrown "open for discussion." We follow this custom in these columns, which provide an opportunity for readers to comment on articles published in HPAC; discuss other topics of interest to heating, piping, and air conditioning engineers and contractors; ask questions of authors; etc.

Engineer, Physiologist and Psychologist Are Involved in Heating, Conditioning

THE EDITOR—I read the article by B. von Haller Gilmer, which was published in the June HPAC, very carefully and found it of interest. I would like, however, to make a few comments on it.

I got the impression that the author's data—or should I say his comments?—were concerned for the most part with thermal stimuli to the skin by contact between the skin and warm or cold objects. In heating practice this is, of course, rather rare and so little heat is applied by conduction between the skin and the heating medium or part of the heating system as to be almost negligible.

Could an article be developed to include the behavior of the *glomus bodies* when subjected to "convective heat stimuli" and "radiation heat stimuli," if I may use such terms to indicate my meaning? Again, only a small proportion of the total skin area is directly affected by heat sources because of the clothing. What are the effects of clothing of different kinds on the behavior of the glomus bodies and what effect have the air spaces between the clothing and the skin? Could these points be developed? (compare The Relative Influence of Radiation and Convection Upon the Temperature Regulation of the Clothed Body, by C.-E. A. Winslow, L. P. Herrington and A. P. Gagge, American Journal of Physiology, October 1938, p. 51).

Another point worth consideration is the rate of response of the glomus bodies and I have in mind the immediate sensation of overwarmth experienced on entering a room with an ambient temperature of 70 F from the outdoors at, say, 30 or 35 F, whereas some time afterwards the same room may feel on the cool side.

"Leaving Shock"

How is the so-called "leaving shock" explained by the action of the glomus bodies? Some people say it doesn't exist, but almost every operator of a movie theater has been concerned at one time or another about heat prostration cases which are said to occur when persons leave an overcooled theater and go outdoors during the heat of a summer day. Only the other day, in conversations with railroad officials, we were told of their concern over a number of cases of people apparently suffering from heat prostration on leaving a cooled pullman car in the South during the summer (daytime).

Dr. R. W. Keeton, of the college of medicine of the University of Illinois, a member and for some time chairman of the ASHVE technical advisory committee on physiological research, presented a paper before the society in 1940 on The Peripheral Type of Circulatory Failure in Experimental Heat Exhaustion, ASHVE Transactions, Vol. 46, 1940, p. 157. Dr. Charles Sheard and his colleagues discussed the "role of the extremities in the dissipation of heat from the body in various atmospheric and physiological conditions" before the society in 1939, ASHVE Transactions, Vol. 45, p. 135. There are numerous other references at the end of chapter 12, Physiological Principles, of the 1946 edition of the Heating, Ventilating, Air Conditioning Guide.

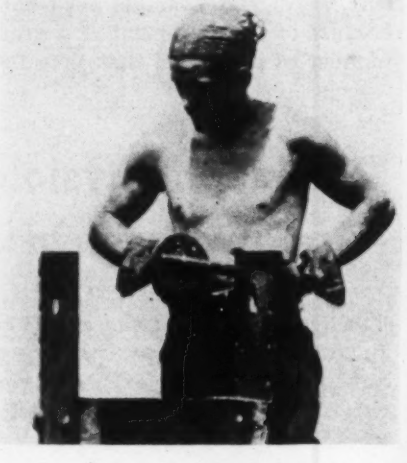
In Dr. Gilmer's article, the terms "temperature insulation" and "temperature conductors" are used. Does he not mean "heat" instead of temperature? Do the "sweat ducts" actually conduct any heat as such? They bring moisture to the surface of the body and the evaporation of this moisture causes cooling of the wetted area of the skin.—CYRIL TASKER, director of research, American Society of Heating and Ventilating Engineers.

THE EDITOR—The questions raised by Mr. Tasker are legitimate ones, but I cannot answer them at the present time. For example, I know of no researches which have been conducted on the behavior of the glomus bodies to "convective heat stimuli." Again, I know of no data that would explain the so-called "leaving shock" phenomenon.

His comments certainly bring up a number of problems for investigation. I feel this entire field of research is only getting started. My work on the glomus bodies is only a small part of the more general problem and until we can learn more of the physiological functions of this organ to stimulating conditions of the kind he describes I hesitate to theorize too far.—B. VON HALLER GILMER, associate professor of psychology, Carnegie Institute of Technology.

How the Body Regulates Loss of Heat Through Its Surface

THE EDITOR—The body produces variable quantities of heat internally (viscera and muscles), stores sufficient of it to maintain a rectal temperature of 99.6 F, and dissipates the remainder through the surface. The quantity of heat stored varies slightly in health, but more widely in disease. This is controlled by the heat center in the hypothalmus. The regulation of the loss of heat through the surface of the body is of the greatest interest to the engineer, and it is to this subject that the discussion of Dr.



The body produces variable quantities of heat

B. von Haller Gilmer, in the June HPAC, applies.

Heat is conveyed to the surface by the blood, whose temperature drops from 99.6 F to 91 F in the skin over the body generally, and to much lower values in the skin covering face, hands, and legs. The volume of blood circulating usually remains relatively constant with 10 to 15 per cent fluctuations (Glickman, Hick, Keeton, and Montgomery[1]). However, this volume is in communication with reserve supplies in the spleen, liver, and skin (Meek and Eyster[2]; Wollheim[3]). The flow through these reserve areas is often so low that considerable quantities of blood may be trapped and for the time be excluded from the circulation. With changes in physiological demands, the blood vessels of any one of these areas may open and contribute extra quantities of blood.

Since with a constant pressure the rate of flow through a tube varies as the fourth power of the diameter, one can easily see that the enlargement of the vessel will increase the flow tremendously.

Blood Flow Under Hot Conditions

The flow of the blood through the skin under hot conditions is seven times greater than under comfortable conditions (Keeton, Hick, Glickman, and Montgomery[4]). Clark's studies[5] have demonstrated the mechanism by which this increase in the flow is accomplished. Between the extensive capillary network of vessels through which the blood moves in a leisurely manner from the arteries to the veins, shunts have been described. These consist of contractile arteries reinforced with epithelioid cells and supplied with nerves. On the application of heat the shunt (arteriovenous anastomosis or glomus) opens and blood pours through it; with the application of cold, the process is reversed.

Dr. B. von Haller Gilmer has proposed that the glomic bodies in the skin function not only as temperature regulators in response to incoming stimuli, but also as the sensory mechanism for temperature feelings. There has been no general agreement as to the receptors which give rise to heat and cold sensations. It would seem that they are intimately connected with the glomus, but that they have central connections also from which the sensations of heat and cold arise.

Warming of the heat center of the hypothalmus causes a secretion of sweat and an increased flow of blood through the skin. Indeed, sweat may be secreted after the vessel to the extremity is occluded. The glomus, therefore, appears to be responsive to stimulation by the application of thermal changes to the skin or to the center.

Dr. B. von Haller Gilmer has pointed out the necessity for allowing sufficient time to elapse after entering a new environment to stabilize the temperature adjustments, an end which is presumably accomplished by setting in action the proper number of glomic bodies. It can be seen that if the clothing on the body carries appreciable quantities of water, this stabilization may be postponed due to the evaporation of water from the clothes. Yaglou[6] has shown that the different types of clothing worn by men and women are largely responsible for their lack of comfort in the same environment. If the clothing was exchanged, the women were warm and the men cold.

Acclimatization

There is still the problem of acclimatization of individuals to environments which are cooler or warmer than the average. It is conceivable that acclimatization may be due to modifications of the intensities of heat and cold sensations arising from the same quantitative stimuli. This would be due to an adaptation in perception. Clark has shown in the rabbit's ear that the glomic bodies may be increased in number by exposure to heat and be decreased by exposure to cold. Acclimatization might then be a physiological adaptation by which the number of the glomic bodies was altered to meet long range environmental changes.—ROBERT W. KEETON, M.D., head, department of medicine, college of medicine, University of Illinois.

[1]Glickman, N., Hick, F. K., Keeton, R. W., and Montgomery, M. M.; Blood Volume Changes in Men Exposed to Hot Environmental Conditions for a Few Hours; American Journal of Physiology, 134, pp. 165-176, 1941.
[2]Meek and Eyster; American Journal of Physiology, 61, p. 186. 1922.
[3]Wollheim; Ztschr. f. Klin. Med. 116, p. 269, 1931.
[4]Keeton, R. W., Hick, F. K., Glickman, N., and Montgomery, M. M.; The Influence of Physiological Research on Comfort Requirements; American Society of Heating and Ventilating Engineers Journal Section; 1941.
[5]Clark; Physiological Reviews, 18, p. 229, 1938.
[6]Yaglou, C. P., and Messer, A.; J. A. M. A., 117, p. 1261, Oct., 1941.

Quality Air Conditioning—

(*Concluded from page* 91)

which (in his opinion) are required in order to meet the performance guarantees. This is a method that has in the past proved to be acceptable in assuring quality air conditioning installations.

There is another method that has been pursued and highly successful in the results obtained, which combines the efforts of the air conditioning consultant and the air conditioning contractor: The consulting engineer allows freedom of design and the selection of equipment but definitely performs his duties by specifying, if he so desires, minimum capacities of apparatus, and outlines the space conditions governing both the installation and the apparatus. The consultant also coordinates all of the coincidental work, such as the structural design for the housing, the electrical power system, the steam and return heating connections, and the plumbing and drain connections. Freedom of design with the consultant's approval and the selection of proper equipment to do the work is allowed the air conditioning contractor and he is then responsible for the performance guarantees. In this manner, the combined engineering experience of both the consultant and the air conditioning contractor is utilized in the design and arrangement of equipment, and all of the air conditioning contractor's installation technique and know how is utilized.

There are many other necessary requirements that the air conditioning contractor has to be familiar with, such as local building codes, local laws on minimum ventilation, local ordinances covering the installation of refrigerating equipment where such are in effect, and the American Standards Association safety code for the installation of refrigerating equipment sponsored by the American Society of Refrigerating Engineers.

Then we also have the requirement that all clients, almost without exception, must of necessity insist that the installation conform with the standards of the national fire underwriters in order that the safety provisions covering life and property are adhered to.

Steps Contractor Must Follow

Summarizing the steps that the air conditioning contractor must follow in order to assure quality in air conditioning installations, they are briefly:

First, the design and installation technique that only experience teaches, combined with competent field men who by long experience have learned the artistry of sheet metal construction, piping systems (including the difficult refrigerant piping technique), and the thorough operating knowledge of all types of refrigeration.

Second, the thorough assimilation of the proven data that has now been evolved covering air conditioning, especially for comfort. This assumes that the psychrometric chart has been thoroughly studied and assimilated so that its use is almost second nature.

Third, the know how comprising the many years of experience and brains of the older men and the younger men, to make air conditioning systems function properly.

Fourth, the younger men entering the business, whether they be engineers or mechanics, should provide themselves with the necessary proven data which are available from many sources, and if financially able, take a course from an authoritative school in the complete engineering fundamentals, design application, and installation practices now current.

The author believes that without exception you will find the many specialists in the air conditioning industry to be quite willing and quite enthusiastic in helping those that wish to enter this industry in quickly obtaining the necessary practical and fundamental experience. The author does not subscribe to the theory that a six weeks' course in air conditioning will make any one a specialist. Rather he would have the younger men understand that this is a very difficult and arduous task and that it will take years and not weeks to become really competent and useful.

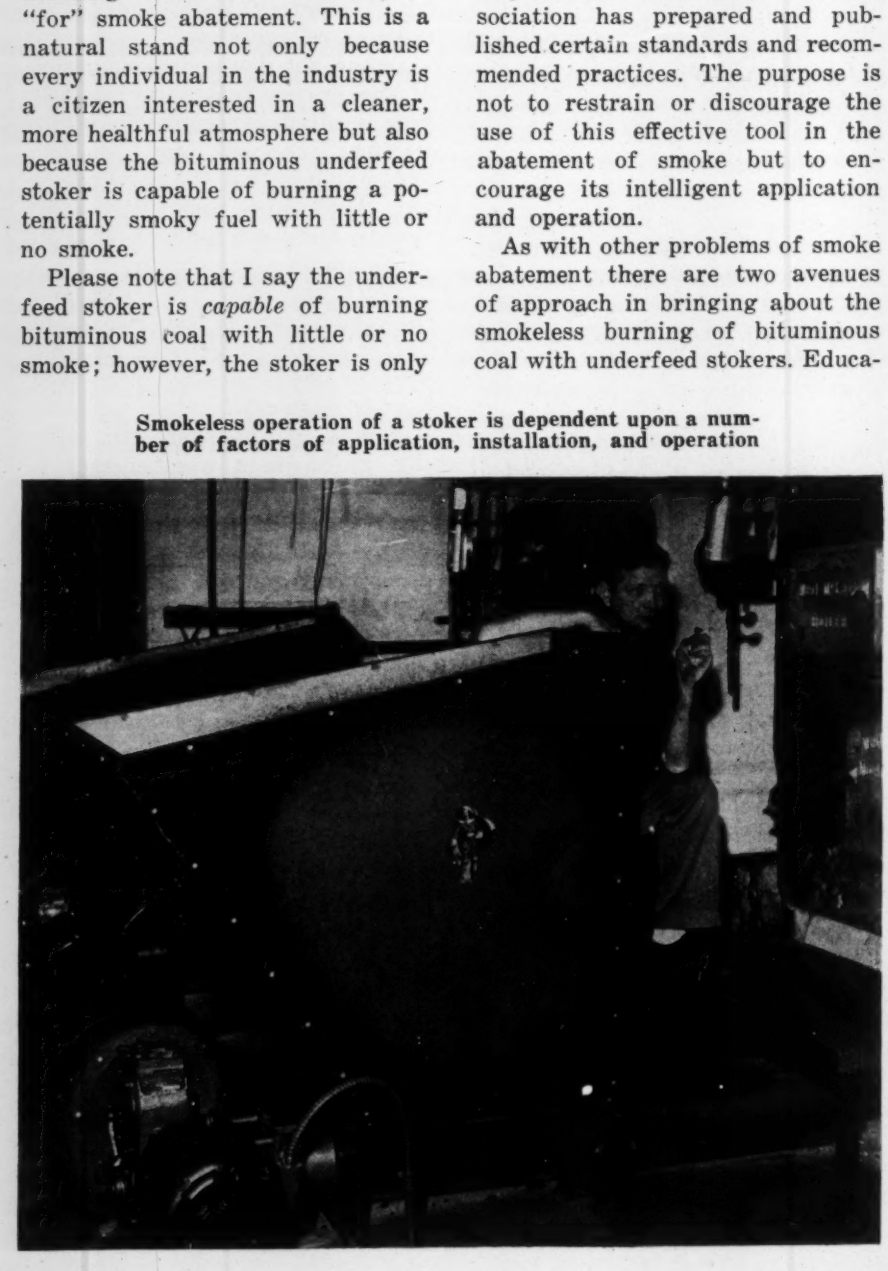
Stoker Industry Aids Smoke Abatement Work

IN THE midst of postwar confusion, when important national issues find even the top men of the nation simultaneously "for" and "against," a simple statement of policy on any subject may be refreshing: The stoker industry is "for" smoke abatement. This is a natural stand not only because every individual in the industry is a citizen interested in a cleaner, more healthful atmosphere but also because the bituminous underfeed stoker is capable of burning a potentially smoky fuel with little or no smoke.

Please note that I say the underfeed stoker is *capable* of burning bituminous coal with little or no smoke; however, the stoker is only a starting point and its smokeless operation is dependent upon a number of factors of application, installation, and operation. That is why there are rules and regulations governing these factors and why the Stoker Manufacturers Association has prepared and published certain standards and recommended practices. The purpose is not to restrain or discourage the use of this effective tool in the abatement of smoke but to encourage its intelligent application and operation.

As with other problems of smoke abatement there are two avenues of approach in bringing about the smokeless burning of bituminous coal with underfeed stokers. Education affords the greater opportunity for industry to participate as it is currently participating in the educational program of the combustion equipment standardization committee of the Smoke Prevention Association. The Technical Manual on Industry Standards, Recommended Practices and Technical Information as published by the SMA also contains material of educational value in smoke abatement activities. The detailed installation and operating instructions published by the individual manufacturers and their training programs for installers and servicemen also fall within the educational approach. The legal approach—as in the city ordinance and rules and regulations of city smoke departments—affords opportunity for participation by industry only to the extent acceptable to city officials. I am glad to say that the smoke department officials of some cities have welcomed the counsel of affected industries on such matters.

Smokeless operation of a stoker is dependent upon a number of factors of application, installation, and operation



Within the SMA's engineering and research committee is a permanent subcommittee on smoke abatement which is devoting considerable time and serious study to the smoke abatement problem insofar as it applies to single retort underfeed stokers of 1200 lb per hr capacity or less. The most recent work of this committee has been the preparation of a discussion on factors affecting the smokeless operation of underfeed stokers. It was felt that such material may, through a better understanding of these factors, serve as a useful guide to stoker distributors, installers, and others interested in the subject. Although final action has not yet been taken to release this material for publication, I

would like to take this opportunity to give a portion of the present draft:

Stoker Installation for Smokeless Operation

The following factors pertaining to the installation of a stoker will be discussed in reference to their effect on the smokeless operation of the equipment.

a) *Setting Heights*—The stoker setting height is an important consideration from the standpoint of smokeless operation. Frequently, however, adequate care is not given to the coordination between this factor and others of equal importance—such as boiler or furnace design, ash storage space and cleaning conditions—to obtain an installation that will give best overall performance.

General furnace proportions, and the design and location of the heat absorbing surfaces, vary considerably the optimum stoker setting height for different installations. Cleaning arrangements and ash storage space in the furnace are particularly important.

Because of the wide variation in the above influencing factors, it is not possible to establish a schedule of stoker setting heights that will be suitable for all installations.

However, the SMA has prepared, after an extensive study of the subject, including an investigation by an independent scientific laboratory, recommended minimum setting height standards.*

These standards have been used as a guide by the industry since 1939, with very satisfactory results. They have also been adopted by a number of cities for incorporation in their rules and regulations governing stoker installations.

b) *Furnace Volume*—Although adequate furnace volume (combustion space) is required for smokeless operation, this factor is influenced, even more than the stoker setting height, by furnace proportions and the design and arrangement of the heat absorbing surfaces. Stoker design and fuel characteristics also affect the furnace volume required.

These variable factors explain the reasons why many applications give excellent performance at heat release rates in excess of 100,000 Btu per hr while others must be as low as 20,000 Btu per hr.

In general, large power plant equipment requires much lower heat release rates for satisfactory operation than small commercial or domestic heating plants.

Under average conditions, underfeed stokers of 1200 lb per hr capacity or less will give excellent performance at heat releases of 60,000 Btu per cu ft, and in many instances much higher releases give satisfactory results. The SMA has established a maximum recommended value of 60,000 Btu per cu ft.

c) *Ash Storage*—Adequate space should be provided in the furnace for the accumulation of ash or clinkers between cleaning periods—taking into consideration the percentage of ash and ash fusing temperature of the coals normally used in the locality.

The preferred nominal stoker grate or hearth dimensions are shown in the SMA's suggested fire-box dimensions.† These recommendations show average preferred values. In many instances smaller fireboxes will perform satisfactorily but the dimensions shown are preferred minimums. When it is necessary to pit the stoker to provide minimum setting heights or combustion volume, the dimensions of the furnace may necessarily be reduced to provide for ample protection of the mudring of the boiler.

d) *Accessibility for Cleaning Fires, Flues, and Stoker Windbox*—For smokeless and efficient operation of stoker installations, regular attention is required to removal of clinkers from the firebox, cleaning of boiler flues, and periodic removal of fine coal siftings from the stoker windbox beneath the retort. Accessibility for these cleaning operations must be provided when the stoker is installed.

The stoker hopper (or other obstructions) must be a sufficient distance from the boiler front to permit full opening of firing doors and flue cleanout doors. If boiler room space does not permit this, the hopper may be hinged so that it can be swung out of the way when necessary.

On front installations, it is often possible to use the original firing doors for removal of clinkers; however, on some pitted installations, when the retort is set too far below the regular boiler fire doors for convenient cleaning, an auxiliary cleanout door or doors should be provided near the hearth level.

When cleanout doors are near or below floor level on pitted installations, the pit should be made wide enough for the fireman to stand in it when cleaning the fire.

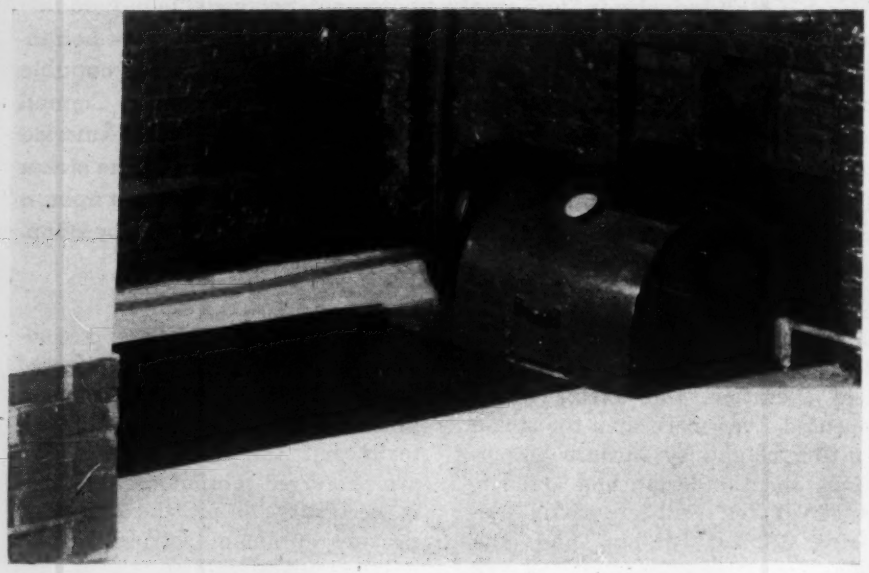
On the side installations of larger stokers, adequate provision

*Recommended Standards Governing Minimum Setting Heights, section 4 of the technical manual of the Stoker Manufacturers Association.

†SMA Suggested Minimum Firebox Dimensions and Base Heights, section 4 of the technical manual of the Stoker Manufacturers Association.

THE STOKER industry is "for" smoke abatement, because the individuals in the industry are citizens naturally interested in a cleaner, more healthful atmosphere and because the bituminous underfeed stoker is capable of burning a potentially smoky fuel with little or no smoke, Mr. Connell told the members of the Smoke Prevention Association of America assembled in convention at Minneapolis last month. However, the stoker is only a starting point and its smokeless operation is dependent upon a number of different factors of application, installation, and operation.

Lloyd L. Connell, Technical Director of Stoker Manufacturers Association, Describes Activities of SMA at Smoke Prevention Association's Convention



It is not possible to establish a schedule of stoker setting heights that will be suitable for all installations

must be made for removal of clinkers from the far side of the retort without undue disturbance of the fire bed.

All stokers (both domestic and commercial) should be provided with a suitable cleanout in the base of the retort or windbox for removal of fine coal siftings which, if allowed to accumulate, may obstruct the air delivery for smokeless combustion.

The cleanout opening must be tightly closed when not in use to prevent escape of air needed for combustion.

Because of difficulties in cleaning, installations in very narrow firebox boilers often give better results from the standpoint of smoke and fly ash discharge if the hearth is set at or near the original grate level, rather than lowering the retort into a narrow refractory lined combustion chamber, even though the setting height may not be up to the minimum requirement.

Smokeless Stoker Operation

Smokeless operation of stoker fired plants is dependent upon proper adjustment of air and coal feed and regular attention to cleaning of fires, flues, and windbox cleanouts. Stoker manufacturers provide operating instruction cards or booklets, which should be kept in a readily accessible place near the stoker for reference as needed.

Adequate firing tools are essential and must be available for proper cleaning of the fire.

Additional Considerations Affect Smoke

Some of the larger installations, because of having to compromise the desired minimum combustion volume and/or setting height, or because of other unusual conditions, may use advantageously an auxiliary blower for furnishing overfire air. The control of the overfire air unit may vary in accordance with the actual need for the equipment. On most installations, this will be limited to a short period after the stoker cuts off. However, because of the fundamental principle of underfeed stoker firing, the use of special overfire air equipment is not required on most underfeed stoker installations.

It is important that adequate ventilation of the boiler or furnace room be provided to insure ample supply of air for smokeless combustion.

Stoker capacities should be selected on the basis of boiler load from the uniform stoker rating charts in section 4 of the SMA's technical manual, except that where boiler loads are less than 75 per cent of the rated capacity of the boiler the stoker should be of a size that will handle at least 75 per cent of the boiler rating.

* * * * *

In addition to the foregoing material further enhancement and improvement of the industry's technical manual can be expected in a new edition to be published early next year.

City Smoke Ordinances

Any large scale program—and smoke abatement is by no means a small one—requires the full cooperation of all of those interested and affected. Cooperation can only exist where there is understanding and a free exchange of views. With this thought in mind, it is only fitting that I should present some thoughts and recommendations relative to city smoke ordinances and smoke department rules and regulations from the viewpoint of the SMA engineering and research committee. These thoughts and recommendations coincide to a great extent with programs now in operation in some cities.

1) The great preponderance in fuel burning plants is in the residential and commercial heating range where the initial cost of installing equipment capable of being operated smokelessly is a major factor in determining whether or not such equipment will be installed.

2) If smokeless operation of coal burning plants in the above categories is to be encouraged, the regulations governing installation of underfeed coal stokers must not impose the needless cost of expensive auxiliary equipment such as might be expected in connection with large power boilers. Regulations pertaining to stokers should differentiate between large power sizes and the smaller commercial and domestic sizes.

3) It is very desirable that the technical rules and regulations governing fuel burning equipment be maintained constantly in tune, on a practical level, with the progressive developments in fuels, combustion technique, and equipment. The city council should not be burdened with this responsibility, and best results in accomplishing the aim and intent of a smoke ordinance can be obtained where responsibility for establishing and maintaining rules and regulations rest with the department of smoke abatement and/or with the interested industries.

Recommendations on City Ordinances

In view of these considerations, it is recommended that no technical rules and regulations be published in the city ordinance, but that they

be provided in one of these ways:

a) Adopting, by reference in the ordinance, the standards and recommended practices of the individual industry, such as those published by the Stoker Manufacturers Association.

b) Providing, in the ordinance, that the chief smoke inspector be vested with the authority to initiate, add to, delete from, and revise the technical rules and regulations governing installation of fuel burning equipment; that the rules and regulations so adopted differentiate between single retort underfeed stokers up to 1200 lb per hr capacity and the larger stokers of industrial or power sizes.

In conclusion, I want to assure the Smoke Prevention Association of the whole hearted cooperation of the stoker industry and the SMA with its worthy cause. We urge the members of the SPA individually and collectively to make full use of the services, experience, and knowledge of the SMA and its members in working toward the objective of cleaner air for American cities.

Greatly Enlarged Market Is Predicted for Air Conditioning and Refrigeration

AN UNPARALLELED market expansion for air conditioning and refrigerating equipment was forecast by S. E. Lauer, president of the York Corp., whose election as president of the Air Conditioning and Refrigerating Machinery Association was announced last month. He said that the industry's greatly enlarged plant capacity, which was more than doubled for wartime manufacture, probably can be fully employed to meet current and prospective demands for improved types of refrigerating and air conditioning machinery.

Large Backlog of Orders

"The industry has a large backlog of orders and has now substantially returned to a peace basis, although plant changes are still being made," said Mr. Lauer. "Delays have been encountered due to shortages of materials and other causes, but conditions now seem to be clearing. The outlook would be splendid if air conditioning and refrigeration faced no more than a resumption of the progress that was being made by the industry in 1941, when the production of consumer goods was largely discontinued.

"The commercial uses of air conditioning are now well established. Most new restaurants, department stores, theaters, food markets, and other retail businesses will incorporate air conditioning. It is safe to predict that no modern office buildings will be built without it. According to a recent survey, an estimated expenditure of more than $1,000,000,000 on air conditioning and refrigerating equipment will be made by the hotels alone in their projected renovation work.

"War and other recent developments have opened many new fields. Air conditioning and refrigeration have become integral parts of numerous manufacturing processes, which a few years ago were conducted without any consideration of controlled temperatures or humidities.

"Refrigeration is now applied to the machine tools used in many heat generating operations. This has allowed industry to accelerate its speed and has greatly reduced work stoppages. During the war the number of metal working plants employing air conditioning increased more than 10 times. Air conditioning has become essential in precision manufacture and also in work calling for highly polished surfaces such as are easily ruined by dust or perspiration. There are many particularized jobs for refrigeration which have not yet come into full usage. Much steel is now cold cured rather than heat treated. The shrink fitting of metal parts is a process which should find increased use.

"Our American productive system continually demands greater speed and higher standards of uniformity and precision. Almost invariably these demands mean that temperature, humidity, and air cleanness must be controlled.

"Of course, the industry's most important job is in the processing, transport and storage of perishable foods.

"The rapidly growing industrialization of the south opens still another sizable market for air conditioning and refrigeration. Many industries, until now largely northern for climatic reasons, can be carried on with the aid of air conditioning or refrigeration in the hottest parts of the nation. Human efficiency, always low in the high temperature and high humidity zones, was increased in southern war plants by the use of air conditioning. Plant working conditions in the south can be brought to a parity with those of the north."

Other officers elected by the association are: First vice president, F. S. McNeal, president of the Universal Cooler Div., International Detrola Corp.; second vice president, George S. Jones, Jr., vice president, Servel, Inc.; chairman of the board, E. T. Murphy, vice president, Carrier Corp.; and vice chairman, E. B. Willams, vice president, B. F. Sturtevant Co. Div., Westinghouse Electric Corp.

ANNOUNCES WELDING AWARD PROGRAM

An opportunity for those engaged in the design, manufacture, or construction of any type of container ("contents stationary," such as tanks, etc., or "contents moving," such as piping, etc.) is offered by the James F. Lincoln Arc Welding Foundation in the announcement of their new $200,000 "design-for-progress" award program.

Complete details of this award program, which closes June 1, 1947, may be obtained by writing the Secretary, James F. Lincoln Arc Welding Foundation, Cleveland 1, Ohio.

AT VIRGINIA BEACH

NDHA Holds First Postwar Meeting

Heating Improvements, Residential Area Service, Metering Discussed

By John F. Collins, Jr., Secretary-Treasurer, NDHA

MEMBERS of the National District Heating Association assembled last month at Virginia Beach for its 37th annual meeting to consider the results of investigations conducted during the year by the technical committees, and to hear the reports of officers and standing committees, and the addresses of guest speakers.

Possibly the subjects of most interest were the more general extension of district heating service to residential areas and the necessity for improvement of metering practice. An entire day was devoted to the latter subject.

Meter Clinic Held

For the "meter clinic," as the meetings of that day were designated, the chairman of the meters and accessories committee, Henry L. Warhanek, superintendent of heating, Wisconsin Electric Power Co., Milwaukee, and his committee members had made much preliminary preparation. Forty companies, furnishing steam service, had submitted 18 questions on the construction, installation, operation, maintenance, and testing of condensation meters and 19 questions on steam flow metering. Ten participating meter manufacturers had furnished replies to the questions.

As an example of the type of questions, the utilities asked if condensation meter bodies in the larger sizes could be made lighter in weight by constructing them of a cast, light weight metal instead of cast iron. A manufacturer replied that the difficulties were (1) the cost, (2) the shorter life and (3) the porosity of present aluminum alloys.

It was stated that gravity meters of aluminum in the three larger sizes had been offered in 1932, but the increased cost prevented their sale. The shrinkage of aluminum castings is twice that of iron, necessitating a complete new set of patterns and core boxes. With the demand for meters so low, the development cost would have to be added to the purchase price. The threads on a case of aluminum would wear out much earlier than those on an iron case. Finally, for the 20 to 25 per cent of the meters used in vacuum service it is necessary to have a less porous material than now can be made of aluminum alloys.

Pedestrian and vehicular traffic present difficulties in steam main installation

Steam Flow Metering

The afternoon session of the meter clinic was devoted to an animated discussion of problems in steam flow metering. The effect of pulsations on meter accuracy, the measurement of small flow during periods of light load, and servicing of flow meters were but some of the problems discussed. As evidenced by the interest shown and the responses from the floor, more simplified steam flow metering continues to be one of the most important considerations of the association. It was agreed to bring up to date, in the light of information produced at the clinic, a metering report originally made a decade ago and to hold similar meetings in the future.

At the opening of the sessions on the second day, after a minute of silence in memory of nine deceased members, President R. M. McQuitty, utilization engineer, Union Electric Co. of Missouri, St. Louis, gave the presidential address. He drew attention to the ever increasing annual sales of district steam and to the excellent financial position of the association itself. He pointed out that during the year the technical committees had not only carried on the usual investigations, but in addition, their members had made excellent progress in preparing the third edition of the district heating handbook. He said the proposed new constitution and bylaws were ready for ratification by the membership and he remarked on the completion of the 10 year index of association publications. In closing, he recommended that more attention be given to publicizing the district heating industry and the association's work.

In his seventh annual report Secretary-Treasurer John F. Collins, Jr., outlined the activities carried on at headquarters in publishing the bulletin, annual proceedings, and 10 year index.

New Constitution Adopted

The new constitution and bylaws, on which the educational committee under Chairman J. E. Seiter, Consolidated Gas Electric Light and Power Co., Baltimore, had been at work for a year was unanimously adopted. Under the new instruments, an executive board of twelve replaces an executive committee of seven members. Manufacturing members for the first time have representation thereon. The minimum dues of utility members are lowered and provision is made for sectional memberships.

J. M. Barnes, Philadelphia Electric Co., chairman of the membership committee, reported an increase in association membership for the year and the lowest number of losses by resignation in recent years.

The report of the insurance committee was presented by H. A. Weitzman, manager, rate and contract department, Rochester Gas and Electric Corp., Rochester, N. Y. The report told of the granting of a 5 per cent reduction in fire insurance rates to steam companies. In it the chairman warned utilities to be sure that the insurance of the contractors they may employ covers damage to others; that the insurance of lessees of utility property covers damage to such property; and that the fire insurance carried is adequate considering the present rising replacement cost of their property. He suggested examination of hold harmless clauses in contracts, and explained such terms as partial loss from fire, determination of depreciation, rate making and analysis, and loss estimating and adjustment. He recommended the installation and regular inspection of company fire fighting equipment, and reported that the War Damage Corp. would cease to function in January of next year.

The final report of the war service committee was made by its chairman, L. S. Phillips, New York Steam Corp.

Mr. Phillips said the sudden ending of the war and the quick demobilization had left many employers not fully prepared to absorb at once the returning veteran and that conflicting opinions as to the veterans rights under the Selective Service Act had been confusing. He said that while the average veteran had proved himself able to take care of himself, they who have "preserved for us the chance to preserve for them all the things that spell America" are entitled to generous treatment by their employers. He warned that many outside organizations are waiting to capitalize on dissatisfaction for their own selfish purposes.

"Sharper Tools" for Selling

Preliminary to introducing the five speakers on the program of the sales development committee, Chairman D. W. Loucks, supervisor of commercial electric and steam sales, Duquesne Light Co. and the Allegheny County Steam Heating Co., Pittsburgh, summarized the present sales situation by a statement that the industry has "sharper tools" to work with than in former days.

Customers and prospects now recognize that it is too costly to have supervisors give time to operating problems such as steam and electric generation. Then, too, there is a "general desire on the part of many owners and managers to dispense with any unnecessary activities or work in providing heating or other services to their tenants and to devote more attention to their own problems, or their specialized product or commodity."

In his paper on new business obtained and losses in 1945, Arthur S. Griswold, Detroit Edison Co., reported that the 35 companies forwarding statistics had increased the number of their customers served by 845 or about 5 per cent, and that the estimated sales of 1,894,168 M lb annually to these new customers were likewise slightly over 5 per cent of the total.

HIGHLIGHTS OF the NDHA annual meeting last month included a meter clinic, reports of the various standing committees, and a group of interesting and well balanced technical papers. . . . A full day was devoted to a discussion of metering problems in connection with both condensation and flow meters. Steps were taken to continue the study of these problems which are felt to be of great importance to the industry. The substantial gains in volume of business enjoyed by the industry during 1945 were cited. About 80 per cent of the companies reported increased steam sales, although 35 per cent reported warmer weather. Approximately 75 per cent indicated an increase in both total and average revenue and a majority reported a normal increase in connected load. . . . Two of the papers presented brought out the fact that the coal industry is taking a long and earnest look at district heating as a means of safeguarding the domestic coal business. A proposed district heating system for Amsterdam, Holland, was described. For this system consideration is being given to the use of heat pumps and employing coolers and deep freeze units together with water from the canals as a source of heat. The use of hot oil for transmitting the heat underground is also being studied.

Three companies had no capacity to add customers. Three others did not add any. Only 24 of the 845 new connections were to new buildings but 213 were to buildings that previously had been served but had discontinued their contracts. Almost one half of the estimated increase in steam sales to new customers goes to resident type buildings such as hotels, previously more difficult to sell. Discontinuances were negligible except in one city where customers taking service during the war, returned to the use of their own boilers when oil again became available.

Residential Area Heating Urged

Coal's Imperative Interest in Complete Development of Steam Utilities was the title of a paper by R. L. Fitzgerald, vice president and general manager, Duluth Steam Corp., which described the efforts of the coal industry to hold its markets against the competition of fuel oil and natural gas. He predicted that in its present good financial position due to the war, coal, with the assistance of the coal carrying railroads, will finance district heating installations in residential areas, as a feasible method "of recovering its markets until ordinary financing means become available."

Research Engineers W. O. Entenmann and W. H. Browne of the Battelle Memorial Institue, engaged in studying the district heating possibilities for the bituminous coal industry, and W. S. Major of Bituminous Coal Research, were present. The gentlemen from Battelle presented a progress report on their study indicating the advantages of district heating for residential areas, but pointed out the difficulties (1) of selling residences in existing built-up sections, (2) of getting labor costs down for such district heating projects, and (3) of securing satisfactory management arrangements. In a written discussion Mr. Fitzgerald took issue with them on the difficulties. He emphasized the necessity of locating heating plants so as to deliver coal by rail rather than by truck.

In a paper, Economics of District Heating for Housing Projects vs Private Plants, H. W. Harrison, Georgia Power Co., Atlanta, compared the cost of heating Techwood Homes and University Homes in his city. Both projects were built by PWA and occupied in 1936. The Atlanta Housing Authority now manages both. Techwood Homes purchases steam while University Homes, being remote from steam service, has its own generating plant. Both are of identical construction. For 1945 when Atlanta had 2827 degree-days the average cost of space heating and water heating of Techwood Homes was $3.06 per month per dwelling unit or 50c per month per M cubic feet. The comparable cost at University Homes was $3.92 and 64c.

The final speaker on the sales development program was engineer W. Beuker, Jr., of Amsterdam, Holland, who addressed the meeting on District Heating in the Plans for the Rebuilding of the Netherlands. Dr. Beuker said heating would have to be considered in the rebuilding of Holland's bombed cities. Utrecht, whose district heating plant is owned by the province, is the only one of note at present in Holland. In that city a great many houses and public buildings are heated by water at 320 F.

Consideration is being given in Amsterdam to the erection of a combination cooling and heating plant of the heat pump type. Heat would be removed from vegetable cooling and deep freezing cellars and from the waters of the canals and transferred to residential units. In Rotterdam a combined power and heating plant is being planned. Oil is also being considered as a heat carrying medium and heat is to be sold at cost as one of the essential necessities of life.

Two turbine and one motor driven pumps serve an electric steam generator

Air Currents Not Used in Radiant Heating

Two papers were summarized on the program of the commercial relations committee, of which A. T. Veness, Rochester Gas and Electric Corp., is chairman.

The first speaker was C. A. Hawk, Jr., A. M. Byers Co., whose paper, Modern Radiant Heating emphasized that "our bodies at all times are heat generating mechanisms which must constantly dispel a certain quantity of heat in order to maintain comfort and health. Consequently, it is incorrect to consider a heating system as supplying heat to the body—instead, it is more proper to think of a heating system as merely being a barrier against an excessive rate of loss of body heat in cold weather." He said that while the body loses heat in several ways, the greatest loss is by radiation to surrounding surfaces. Radiant heating systems differ from conventional ones in that they

New York City government on the work of installing steam mains and services for several important customers in 1945. Also covered were the methods by which unusual difficulties resulting from underground structures, obstructions, and surface pedestrian and vehicular traffic were overcome in the prosecution of the work.

Electric Boilers Proposed

The installation of electric steam generators on district steam systems for operation during periods of peak steam demand when occurring simultaneously with low electric demand was proposed by H. C. Mittendorf, Combustion Engineering Co., Inc. He pointed out the lower first cost of such installations, the lower operating and maintenance costs, the improved efficiency, the absence of standby losses, and intangibles such as increased cleanliness.

Extending Life of Older Boilers

"Anything that can be done to extend the useful life of older boilers is worth while from a plant investment point of view." Chairman of the steam station engineering committee, R. B. Donworth, Duquesne Light Co. and Allegheny County Steam Heating Co., Pittsburgh, discussed this subject in his paper. He described the procedure carried out in repairing the drums of older boilers where the extent of deterioration due to chemical corrosion, embrittlement, and overheating had been difficult to determine and how such conditions may be avoided in future installations. He stated that the total cost of repairs did not exceed the carrying charges for one year on an installation of new boilers.

Malone Elected President

At the closing session J. F. Malone, assistant manager of the district steam dept., Consolidated Gas Electric Light and Power Co., Baltimore, was elected president of the association for 1946-47. Mr. Malone is a member of the ASME and the ASHVE and is a past president of the Air Conditioning, Heating and Ventilating Engineers of Baltimore.

R. D. Martin, assistant vice president and manager of sales, New York Steam Corp., was elected first vice president, H. L. Martin, Boston Edison Co., second vice president, and D. W. Loucks, supervisor of commercial electric and steam sales, Duquesne Light Co. and the Allegheny County Steam Heating Co., Pittsburgh, third vice president.

These men, with retiring president R. M. McQuitty of St. Louis; John F. Collins, Jr., secretary-treasurer, Pittsburgh; J. T. Davis, manager of steam heating, Indianapolis Power and Light Co.; G. H. Tuttle, heating engineer, The Detroit Edison Co.; A. T. Veness, sales engineer, Rochester Gas and Electric Corp., Rochester, N. Y.; O. J. Prentice, director of publicity and public relations, C. A. Dunham Co., Chicago; J. A. Barnard, superintendent of the coal bureau and steam heating section, Philadelphia Electric Co., and W. A. Schulmeister, sales manager, American District Steam Co., North Tonawanda, N. Y., are the new directors sitting on the enlarged executive board of the association.

Messrs. Prentice and Schulmeister are the manufacturers' representatives. Secretary Collins begins his eighth year as secretary-treasurer.

CPA Reports on Its Building Control Order

During the first 11 weeks' operation of its building control order the Civilian Production Administration handled more than half a million inquiries and applications for non-housing construction, Administrator John D. Small reported on June 25.

Of this flood of requests from persons who wanted to build, CPA was able to turn back approximately 450,000 projects before they reached the formal application stage by persuading the applicants that their projects either were not essential or that they could be deferred. From the remaining 10 per cent—nearly 50,000 who were convinced that their projects were essential and nondeferrable or where stoppage would have resulted in extreme hardship—CPA sifted out 31,457 for approval and denied 14,971, Mr. Small said.

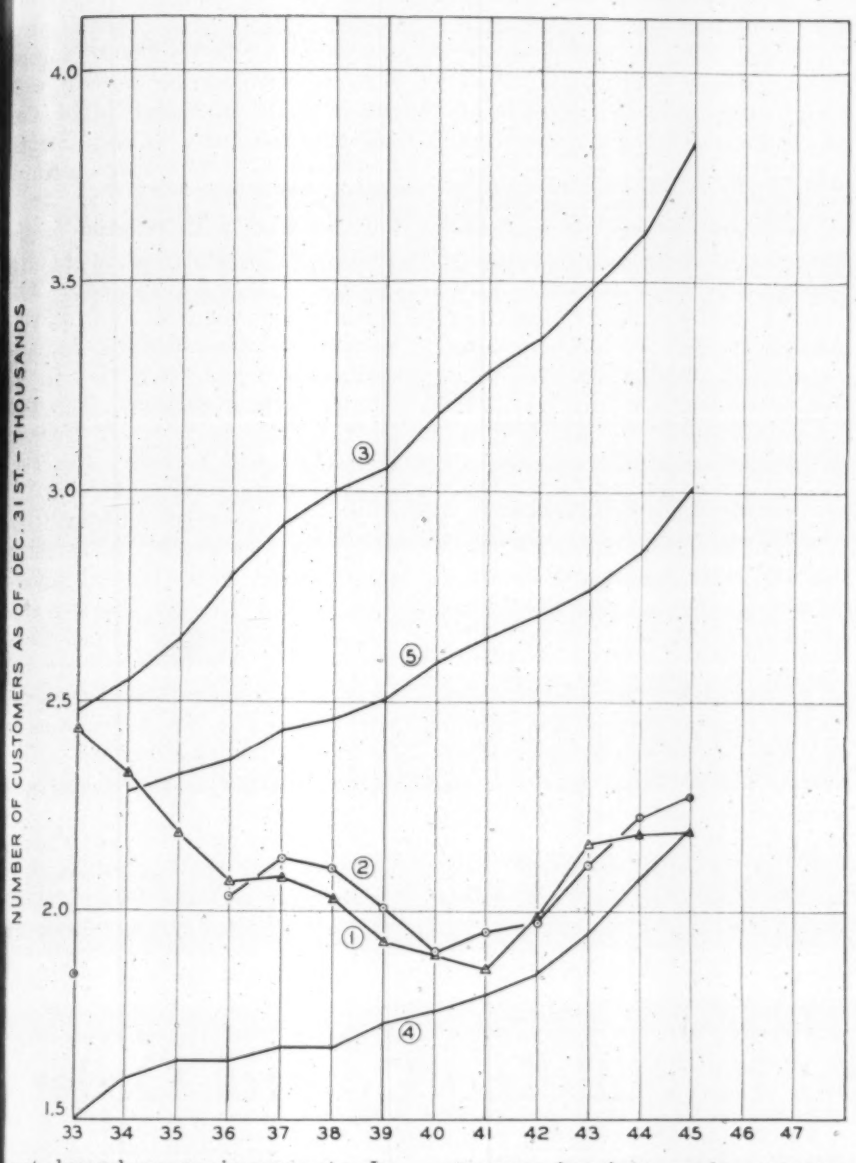
"We had to take a big bite out of the nation's demands for construction in order to give the right of way to homes," Mr. Small said, "and the results show that this is being done." He pointed out, however, that some industrial and commercial work must go forward not only to take care of the needs of new communities, but also to provide job opportunities. The veterans themselves need jobs as well as houses, Mr. Small emphasized.

Construction cost of the projects approved total $1,370,751,048, "a very small fraction of the cost of the 450,000 projects that would have gone ahead had there been no order," Mr. Small said.

In the first month after the issuance of the order, a flood of applications poured in for projects which were ready to get under way and where the facts, in most instances, indicated that denial would result in serious hardship. These were applications covering building projects on which such an amount of money had been committed in materials purchases and engineering preparation that refusal to approve the project would have imposed an extreme hardship, even to the point of bankruptcy in some cases.

Once this peak of "hardship" cases was passed, the dollar value of approvals dropped week by week, and the value of denials rose steadily, Mr. Small said. He pointed out that even before CPA cut its rate of authorizations by two-thirds, approvals had already been reduced very substantially from the "hardship peak" rate.

High point of approvals came in the week of April 19 to 25, less than a month after VHP-1 was issued, when CPA authorized $229,955,561 worth of construction and mechanical equipment, i.e., plumbing, heating, lighting and ventilating equipment. Denials for that week had a construction and mechanical equipment value of $39,533,059.



The increase in district heating customers from 1933 to 1945 is indicated on this chart. The reports of NDHA member companies are divided into five groups based on annual steam sales as follows: (1) over 10 million Mlb, (2) 2 to 10 million Mlb, (3) 1 to 2 million Mlb, (4) ½ to 1 million Mlb, (5) 275,000 to 500,000 Mlb. (Mlb = 1000 lb)

not depend upon air currents. Instead they warm the surrounding surfaces to the point where body heat losses are low enough for comfort.

Mr. Hawk also touched on the subject of snow removal by melting. He said the initial cost of installations in most communities would be between 30c and 50c per square foot of surface. For a system designed to melt 1 in. of snow per hour with 12,000 Btu coal at $5.00 per ton, 1 in. of snow can be removed from 1000 sq ft for 3c.

Chairman Veness was the author of the final paper of his committee. As a guide to steam companies that might wish to publish such a leaflet, he outlined the proposed contents of a nontechnical pamphlet for prospects and customers.

Under the leadership of the rates and regulations committee chairman, H. A. Weitzman, Rochester Gas and Electric Corp., notable progress has been made on preparation of the rates and regulations chapter for the third edition of the district heating handbook. Mr. Weitzman and his committee presented a first draft of the proposed chapter which was discussed.

Industry Gains in 1945

An overall picture of the district heating business in 1945 was given by the operating statistics committee chairman, T. P. Brown, Jr., New York Steam Corp. Mr. Brown said that 80 per cent of the companies reported increased steam sales, although 35 per cent of these companies reported warmer weather. Approximately 50 per cent of the companies reported colder weather; 75 per cent indicated an increase in both total and average revenue and a majority reported a normal increase in connected load.

The cost of fuel per million Btu continued to increase but the increase was less than those reported for 1943 and 1944. There was a general increase in the number employed and in the hourly rate of pay. The hourly cost increased approximately 5 per cent.

There was a slight increase also in the total invested capital and the proposed capital expenditures for 1946 increased approximately 200 per cent over those proposed in a previous report for 1945.

Furnace Failures Studied

In a paper, Instrumentation for the Study of Furnace Performance, the chairman of the research committee, A. R. Mumford, Combustion Engineering Co., pointed out that furnace failures occur because of abnormal rather than average conditions. He described test methods based on four types of measurement — combined surface temperature, circulation velocity, fluid density, and calorimetric— giving substantially the same results and, therefore, permitting a choice, by which it is hoped to study the difference in performance in several furnace zones with respect to overall performance.

Steam Trap Practice Described

Paul Chenzoff, Philadelphia Electric Co., was the first of two to present papers on the program of the distribution committee. In his paper, Prevailing Methods of Trapping Condensate from Steam Distribution Mains, he summarized the practices of eight companies as regards the trapping and disposal of condensate from steam distribution mains with respect to trap types, spacing, location, bypasses and duplication, drips, flash tanks, sewer connections, cooling coils, insulation and corrosion.

Chairman J. J. O'Brien, manager of distribution, New York Steam Corp., concluded his committee's program by describing the restrictions as to working hours, area opened up, decking, and disposal of material placed by the

LIVELY SESSIONS

Contractors Discuss Heating System Details and Pipe Welding Procedure

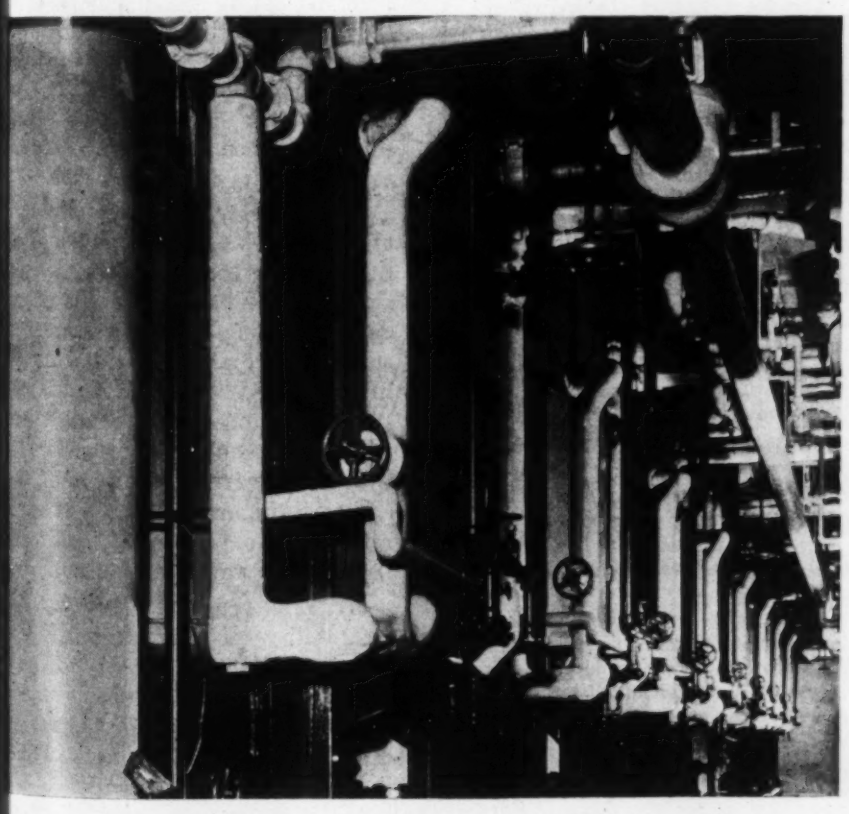
COMPLETING our report of the HPACCNA's recent annual convention, we summarize here the questions and answers on radiant heating, and some of the reports on pipe welding procedures which were presented and discussed at this important meeting.

FOLLOWING THE lively "round-table" session on radiant heating at the Atlantic City convention of the Heating, Piping and Air Conditioning Contractors National Association (reported on pages 74-76 of the June HPAC), there was an equally lively question and answer period on installation details and miscellaneous items.

It was asked if there would be danger of electrolytic corrosion when using copper tubing and metal lath in a ceiling heating installation, and the speakers were agreed that there should be no danger whatever from this, "especially as it would require moisture to cause corrosive action." In connection with the ceiling installation described by J. L. Bradfield, he was asked about the temperatures, and replied that the water into the coils was usually at 130 F, and out at 110 F; with a 110 F mean water temperature, he said that the ceiling panel temperature would be around 92 F, although more complete data on this would be available later on.

A contractor said that he proposed to use the condensate from a large steam heating system in a radiant heating system in another part of the building, and asked for opinion on the feasibility of the scheme. The consensus of the speakers, in replying, seemed to be that this would not be too good an idea, particularly due to the possibilities of corrosion when using condensate in the pipe coils. It was suggested that if it was desired to utilize the heat content of the condensate, it would be better to install a heat exchanger so that the water in the radiant system could be recirculated over and over again without corroding the coils.

This view of a row of fermentation tanks at the Abbott Laboratories is indicative of the vast amount of piping which is essential to modern industrial processes



Use of Antifreeze

A member of the audience inquired if antifreeze solution could be used in a radiant system, and it was agreed that this could be done if the difference in viscosity between such a solution and water was allowed for. The usual antifreeze would require a 15 per cent greater flow for the same heat conveyance, and the pressure drop through the coils would be 40 to 50 per cent greater. One of the speakers said that threaded joints might give trouble with antifreeze, and that welded or gasketed pipe joints had better be employed.

Is it possible to have a cork floor with a floor panel system? one contractor inquired, and the answer was that there had been no evidence of any difficulty with any sort of floor covering—cork, tile, linoleum, carpeting, etc.

Whether to use a sinuous or a grid type of coil was the subject of another question. In reply, C. A. Hawk, Jr., said that a sinuous coil was usually less costly to fabricate and install than the grid type, but if the room was too big, the grid would be necessary on account of

the high pressure loss between supply and return with a long sinuous coil. The two types could be combined in one layout, he pointed out, and he stated that the limiting factor on the grid type is cost and on the serpentine type is frictional resistance.

Radiant Heating Control

In answer to a question on controls for radiant heating, Peter B. Gordon said that modulating the water temperature in accordance with the outside temperature was ideal. He said also that a radiant heating system tends to be inherently self-regulating, as—when the outside temperature is low—a radiant heating panel at 90 F gives off a vast amount of heat, but when the room temperature is close to 90, the panel at 90 F would give off but little heat.

Dry Bulb Thermometers Are Misleading, Engineer Says

Effective Temperature Is the One That Matters in Conditioned Space

By ERWIN J. DAVIS

IT HAS been said that more progress could be made in the acceptance of winter air conditioning if every dry bulb thermometer were dumped into the ocean. Truer statements may have been made, but I doubt it.

The very act of looking at a dry bulb thermometer to learn if you are too hot or if you are too cold, or if you just imagine you are, is an open and final admission of the failure of the dry bulb thermometer as a single indicator of human comfort. How do we reason this statement? This way: If an individual is comfortable, he will not give a thought to *any* thermometer, either wet bulb *or* dry bulb. Whenever an individual takes the mental and physical effort to walk to a thermometer and to note its reading, that individual has a good reason for his actions—he is uncomfortable. He expects the dry bulb thermometer to tell him *why* he is uncomfortable. Does it?

Of course it doesn't. It cannot do it. Suppose the individual feels cold. He looks at the dry bulb thermometer and finds that it reads 76 F. The thermometer has told the individual that he cannot possibly be cold. The individual's brain continues to inform him that he still *is* cold, in spite of what the dry bulb thermometer reads.

The most important temperature is the "effective" temperature.* Effective temperature is the temperature you "feel," regardless of what the dry bulb thermometer reads. But let's get back to that supposition. The dry bulb thermometer read 76 F. If a wet bulb thermometer had been in the place of the dry bulb thermometer, the wet bulb thermometer would quite possibly have read 55 F, and this means that the effective temperature—the *real* temperature—is not 76 deg, as shown by the dry bulb thermometer, but is only 68 deg, and this temperature of 68 deg is the reason that the individual feels cold.

The point is that the individual loses faith in instruments when those instruments disagree with his feeling of comfort. Every individual is a potential user of air conditioning equipment. The public is well acquainted with the fact that the pleasantness of air conditioning depends upon the accuracy of controlling instruments. It also knows that comfort or discomfort should coincide with the reading of the *indicating* instrument—the thermometer. If the reading does not agree with the degree of comfort (or lack of it) the public blames the air conditioning system.

The next move (and it should be an early one) for the air conditioning industry is to choose one of the following alternatives:

1) Move the dry bulb thermometer off the wall, permanently; or . . .

2) Place a wet bulb thermometer permanently beside every single dry bulb thermometer now in use in air conditioned buildings. A wet bulb and a dry bulb reading will determine the effective temperature.

*Effective temperature is defined by the ASHVE's Heating, Ventilating, Air Conditioning Guide as "an arbitrary index which combines into a single value the effect of temperature, humidity, and air movement on the sensation of warmth or cold felt by the human body. The numerical value is that of the temperature of still, saturated air which would induce an identical sensation."

"Need 15,000 Welders"

Numerous reports of the various standing committees of the association were presented at the convention, particular interest being shown in the one on the National Certified Pipe Welding Bureau, given by Roy M. Getschow, the HPACCNA's new national president. He said that the bureau has 11 chapters with some 1500 qualified welders, but that "there should be 15,000." It had not been necessary to make any changes in the present welding procedures, he reported, but said that additional procedures for different alloys should be set up. In this connection, he mentioned that the chrome content of the rod should be the same proportion as the metal being welded.

He emphasized that the contractors are responsible for the welding that they do, and mentioned that they were not getting the desirable degree of cooperation from the unions in some areas.

In giving the report of the editorial committee on the Standard Manual on Pipe Welding, John H. Zink also said that the contractor must keep control of the welding procedures used. He predicted greater use of stainless steel, aluminum, and plastic pipe in the food and chemical industries particularly.

In discussing the importance of qualifying welders on different procedures, and the value of the certified pipe welding bureau, he remarked that his firm had spent some $2200 on one of its welders to qualify him on various jobs.

G. C. Kiefer, associate director of research of Allegheny Ludlum Steel Corp., continued the discussion on pipe welding with his paper on the welding of stainless steel, a subject in which a great amount of interest was shown. In the discussion period following his talk, there was considerable disagreement on the part of various members of the audience regarding the corrosion resistance of different stainless steels under varying conditions.

Mr. Zink suggested strongly the desirability of standardizing the sizes of stainless tubing to iron pipe sizes. Several people mentioned the large field for the use of light weight stainless steel tubing in piping and heating work.

DATA SHEET

PANEL HEATING AREAS

By F. W. HUTCHINSON, Professor of Mechanical Engineering, Purdue

Equivalent Areas for Floor, Wall, and Ceiling Radiant Heating Panels for most Design Conditions used in Practice

A. To convert a known area of **120 F ceiling panel** to equivalent area of some other type of panel, multiply the known area by the coefficient selected from this table:

Surface Temperature	Ceiling Panel	Wall Panel	Floor Panel
85°	***	***	2.22
100	1.67	1.30	1.11
120	1.00	0.78	***

B. To convert a known area of **100 F ceiling panel** to equivalent area of some other type of panel, multiply the known area by the coefficient selected from this table:

Surface Temperature	Ceiling Panel	Wall Panel	Floor Panel
85°	***	***	1.33
100	1.00	0.78	0.67
120	0.60	0.47	***

C. To convert a known area of **120 F wall panel** to equivalent area of some other type of panel, multiply the known area by the coefficient selected from this table:

Surface Temperature	Ceiling Panel	Wall Panel	Floor Panel
85°	***	***	2.84
100	2.14	1.67	1.42
120	1.28	1.00	***

D. To convert a known area of **100 F wall panel** to equivalent area of some other type of panel, multiply the known area by the coefficient selected from this table:

Surface Temperature	Ceiling Panel	Wall Panel	Floor Panel
85°	***	***	1.71
100	1.29	1.00	0.86
120	0.77	0.60	***

E. To convert a known area of **100 F floor panel** to equivalent area of some other type of panel, multiply the known area by the coefficient selected from this table:

Surface Temperature	Ceiling Panel	Wall Panel	Floor Panel
85°	***	***	2.00
100	1.52	1.08	1.00
120	0.90	0.70	***

F. To convert a known area of **85 F floor panel** to equivalent area of some other type of panel, multiply the known area by the coefficient selected from this table:

Surface Temperature	Ceiling Panel	Wall Panel	Floor Panel
85°	***	***	1.00
100	0.76	0.59	0.50
120	0.45	0.35	***

See next page for explanation of use of this table.

Choosing Location of Panel Heating Areas

THE exact rating of 1 sq ft of panel heating surface can be evaluated only in terms of the particular installation. In a room with 65 F air and 75 F mean radiant temperature, the effective comfort temperature will be the arithmetical average, 70 F, but this value cannot be used in calculating energy dissipation from the panel for two reasons: (1) the average temperature of the surfaces which are "seen" by the panel is less than the mean radiant temperature, and (2) the convective and radiant fractions of the equivalent overall film coefficient are not equal, hence an arithmetical average of air temperature and surround temperature is not valid.

For approximate comparisons, however, the two factors mentioned above can be neglected and the relative capacities of floor, wall, and ceiling panels evaluated in terms of design surface temperature, equivalent comfort temperature (taken as 70 F), and overall equivalent film coefficient. Arbitrarily taking 1 sq ft of ceiling panel at a surface temperature of 120 F as a standard, it is then readily possible to calculate the amount of floor or wall surface, at any selected surface temperature, which would dissipate an equal quantity of energy.

As an example consider a floor panel operating at 85 F surface temperature; the area of such a panel which would produce a heating effect equivalent to that of 1 sq ft of 120 F ceiling panel is $[(120 - 70) \times 1.4] \div [(85 - 70) \times 2.1] = 2.22$ sq ft. The table on the preceding page summarizes the equivalent areas similarly determined for most of the panel design conditions which are ordinarily used in practical installations.

Examples Show Use of Table

Example 1: Design calculations for a 120 F ceiling panel installation show that 120 per cent of the ceiling area would have to be heated. Since "difficulty" would arise in heating the 20 per cent of the ceiling that does not exist, some means must be found for providing supplementary wall or floor panels equal in capacity to 20 per cent of the ceiling area. Assume that the designer chooses to use supplemental wall panels at a design surface temperature of 100 F. Entering part *A* of the table, read 1.30 as the correction coefficient, thereby indicating that 1.30×20 per cent $= 26$ per cent of the ceiling area as the necessary size of the supplementary wall panel.

Example 2: A floor panel design shows the need for 250 sq ft of 85 F heated floor surface in a room where bookcases and other interferences reduce the available surface to 200 sq ft. The designer chooses to supplement the floor unit with a ceiling panel at a surface temperature (for maximum load) of 100 F. Entering part *F* of the table, read 0.76 as the correction coefficient giving, therefore, $0.76 \times 50 = 38$ sq ft of ceiling required for the supplementary heat panel.

Example 3: A 100 F ceiling design indicates the need for a panel area equal to 120 per cent of the ceiling area. If the design temperature were raised to 120 F, would the requisite area be reduced sufficiently to permit installation in the ceiling? Going to part *B* of the table, read 0.60 as the correction coefficient, giving $0.60 \times 120 = 72$ per cent of the ceiling as an adequate panel size.

These three examples illustrate three different uses for the approximate relationships of the table. Whenever using this table, however, it should be remembered that it is based on assumptions which are not exact; when the fraction of surface to be converted from one plane to another is small, the error resulting from use of the tabular coefficients will likewise be small, but in cases where the area to be converted is a large part of the total panel area the use of the coefficients may lead to serious error.

In no case should the tabular values be used in basic design; their purpose is to simplify minor modifications that may be required in a design which has been carried out by the usual methods, and when so used the results will be accurate well within the limits of accuracy of the basic design coefficients.

[For a complete discussion of this subject, see article by F. W. Hutchinson in Heating, Piping & Air Conditioning, March 1946.]

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

A Rational Basis for Solar Heating Analysis

By F. W. Hutchinson* and W. P. Chapman**
Lafayette, Ind.

SUMMARY—A rational general equation is developed for determining the heat gain or loss resulting from use of a unit area of window in place of an equal area of non-transmitting wall.

A chart is presented for graphical solution of the saving or loss for a heating season for two latitudes and four combinations of double glass with separating air space when used in a south wall.

Introduction

THE determination of gains or losses resulting from the use of window area in so called solar construction is complicated by many factors; not least of which is the difficulty of effectively integrating, diurnally and seasonally, the varying quantities of solar energy that are transmitted through or absorbed by the window. The present paper develops a rational general equation which can be used to obtain the gain or loss, in Btu per heating season, resulting from the use of unit area of window in place of an equal area of non-transmitting wall. This equation which is developed as Equation 23a in this paper is,

$$Q = F \sum_{n=1}^{n=5088} \nabla_n - 5088(U_c - U_w)(t_i - t_o')$$

where,

Q = annual saving (based on October 1 to May 1 heating season) in Btu due to replacing one square foot of non-transmitting *south* wall with a double glass *solar* window which is 100 per cent in the shade (due to roof overhang) *only* at solar noon on June 21 and 100 per cent irradiated by noon sun (solar time) *only* on January 21.

t_i = the design inside air temperature.

t_o' = the *normal* outside air temperature during the seven month heating season from October 1 to May 1 (Values given on pp. 258-9 of the ASHVE 1946 GUIDE).

U_w = overall coefficient of heat transfer of the unit area of wall which is to be replaced by unit area of window.

U_c = overall coefficient of heat transfer of window, including inside and outside air films, two sheets of identical glass and separating air space.

5088 = number of hours in the selected seven month heating season.

F = fraction of maximum possible sunshine which occurs during an average year in the 7 month heating season (refer to Table 1 for values in representative cities).

$\sum_{n=1}^{n=5008} \nabla_n$ = the summation of solar term, ∇_n, for each of the 5088 hours of the heating season.

$$\nabla_n = E\left\{U_c\left[(r_o + 1.5r_g + r_a)\, q_{a2} + \left(\frac{r_g}{2} + r_o\right) q_{a1}\right] + q_t\right\}$$

in which,

∇_n = a solar gain term representing the reduction in excess normal transmission losses, such excess losses being $(U_c - U_w)(t_i - t_o')$, due to solar irradiation and expressed in Btu per hour. The term ∇_n must be numerically evaluated for each hour between sunrise and sunset of each day of the heating season.

r_o, r_a, r_g = thermal resistances of the outside air film, the air space and *each* sheet of glass, respectively.

E = the effectiveness factor of a solar window; equal to the fraction of the window which is unshaded at a particular hour of a particular day.

q_{a1} = the rate of solar energy absorption (at a given time and day) by the outside sheet of glass, but neglecting absorption of sky radiation.

$= I_o \cos i\, A_{(1\text{ of }2)}$

I_o = solar intensity on a plane normal to the earth's surface and at sea level; varies with time of day and day of month (refer to Fig. 1).

$\cos i$ = cosine of the angle of incidence of sun's rays on a window in a south wall (see Equation 30).

$A_{(1\text{ of }2)}$ = absorptivity of the outside sheet of two identical sheets of glass (refer to Equation 28).

q_{a2} = the rate of solar energy absorption (at a given time and day) by the inside sheet of glass, but neglecting absorption of sky radiation.

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$= I_o \cos i A_{(2 \text{ of } 2)}$

where

$A_{(2 \text{ of } 2)}$ = the absorptivity of the inside sheet of two identical sheets of glass (refer to Equation 29).

q_t = the rate of solar energy transmission (direct *plus* sky radiation at a given time and day) by the window.

$$= I_o \cos i \, T_{1,2} + I_o \frac{T_{s1,2}}{R}$$

where,

$T_{1,2}$ = transmissivity for direct solar radiation at a given time and day of a double glass window consisting of identical sheets of glass (refer to Equation 27).

$T_{s1,2}$ = transmissivity as just described but for sky radiation. This term can be taken as numerically equal to the value of $T_{1,2}$, which occurs at an angle of incidence of 60 deg.

R = ratio of intensity of direct solar irradiation on a plane normal to the sun to intensity of sky radiation on a vertical window; R varies as a function of solar altitude as shown in Fig. 2.

Application of the foregoing rational equation to a solar house assumes two conditions: (1) That the rate of heat loss of the house as a whole will exceed the solar gain at all times during the heating season, or that for brief periods during which this condition is not true the thermal capacity of the floor will be sufficient to permit storage of excess solar energy for later re-use.

(2) That all solar energy transmitted into the house eventually serves to reduce the heating plant output, for fixed inside air temperature, on a unit for unit basis. This condition implies effective insulation of directly irradiated surfaces.

Graphical solutions of this general equation are presented at the end of this paper for four varieties of double glass solar window when used in either of two latitudes; use of these graphs makes it unnecessary for the designer to concern himself with variations in the solar intensity as a function of time or season, or to calculate the angle of incidence. All results given here are for windows facing south.

Included in the integration is a term which takes account of the shading effect experienced during parts of the heating season from the roof overhang that is customarily used with solar construction. Development of additional graphical solutions for use with east and west walls and for localities where unusual atmospheric conditions exist is now underway and results will be reported in a later paper. Further, experimental study of solar heating is now being conducted on thermally and architecturally identical houses on the Purdue Housing Research Campus; results will be reported in the near future.

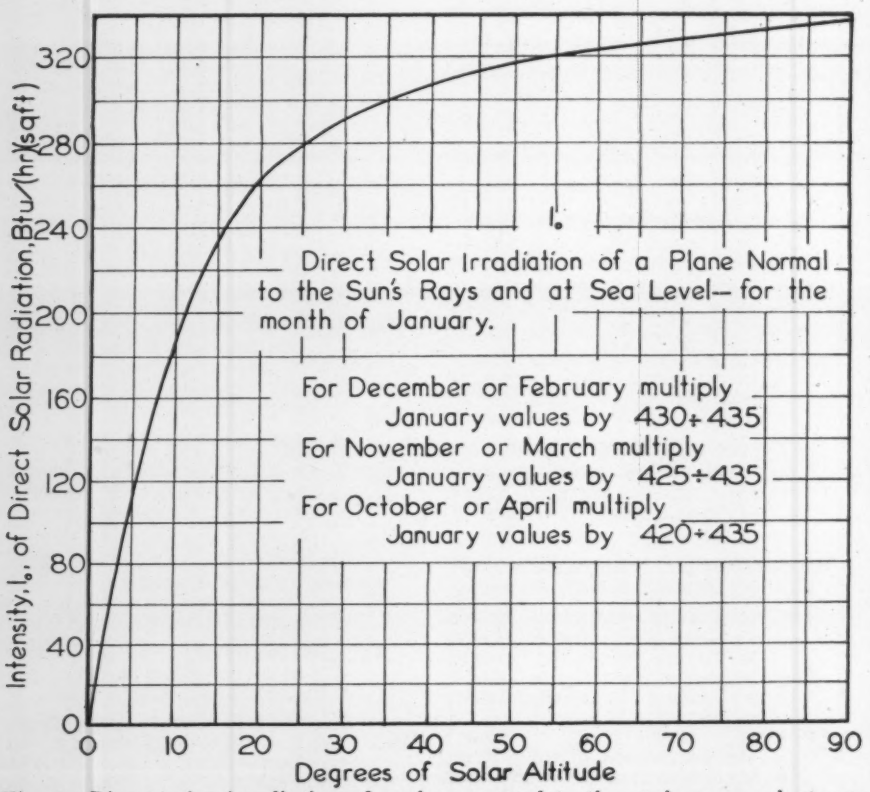

Fig. 1—Direct solar irradiation of a plane normal to the sun's rays and at sea level for the month of January

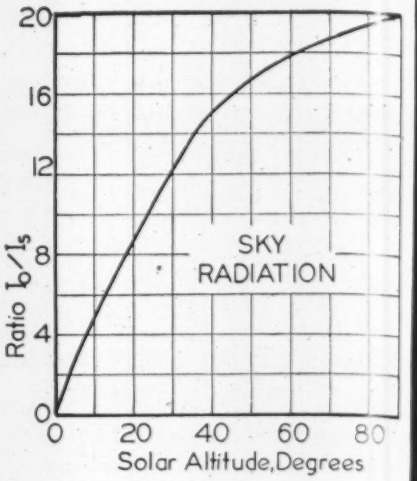

Fig. 2—Ratio of intensity of direct solar radiation in a plane normal to the sun to intensity of sky radiation on a vertical window

Instantaneous Steady State Conditions

The effectiveness, for solar heating, of one square foot of glass depends at any given time on the net reduction (over that required for a corresponding square foot of wall area) in the net rate of heat flow from the heating plant to the surface of the window. Considering that all solar energy transmitted into the room eventually appears as an internal energy increase of the inside air and crediting the solar gain entirely to the glass, it is evident that at a steady state the actual transmission losses through the window will be equal to the sum of the solar transmission gain and the net energy supplied from the heating plant. This relationship can be written in equation form,

$$q_i = q_t + q_h \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where,

q_i = steady state transmission of heat from the interior of the room to the inside surface of the window. Btu/(hr) (sq ft of irradiated glass).

q_t = steady state transmission of solar energy into room through the window, Btu/(hr) (sq ft) of irradiated glass.

q_h = steady state makeup of energy from the heating plant required to maintain the inside air temperature at a predetermined value.

The most important qualification of Equation 1 arises from the assumed condition that solar transmission gains serve to reduce, unit for unit, actual transmission losses from the room. In order for this to

be true all radiant energy entering through the window would have to be absorbed within the room and later released to the room air or reradiated (at long wave length) from a room surface. The first condition implies no direct loss through the window of reflected (from an interior room surface) solar radiation, whereas the second condition implies zero exposure (or perfect insulation) of the interior surface at which the solar radiation is absorbed; since by far the greater fraction of solar energy is received at the floor of the room it follows that the floor is assumed to be a non-transmitting surface. Note that for the problem now under consideration the thermal capacity of the floor is not an influencing factor since for a steady state condition there can be no passage of heat either to or from storage.

In order to solve Equation 1 for q_h the other two terms must first be evaluated. Heat transfer from the room to the inside window surface is given by,

$$q_i = h_i(t_i - t_{gi}) = q_i + q_h \quad \ldots\ldots (2)$$

where t_i and t_{gi} are the temperatures of the room air and the inside surface of the window, respectively, whereas h_i is the combined coefficient for heat transfer by radiation and convection from the room to the window. Equation 2 is not yet subject to direct solution, however, as it contains two terms which need to be evaluated, q_h and t_{gi}; the latter term depends not only on the overall coefficient of heat transfer for the window and on the outside air temperature, but also on the quantity of solar radiation absorbed by the glass.

Consider that the window consists of two identical thicknesses of glass separated by an air space (Fig. 3) the outside sheet absorbing q_{a_1} and the inside sheet absorbing q_{a2} Btu/(hr)(sq ft). Then let r_g, r_a, and r_o represent, respectively, the thermal resistances of one sheet of glass, of the separating air space and of the outside combined film coefficient. Let t_{gx} be the temperature at the midplane of the inner glass, t_a the airspace temperature and t_o the temperature of the outside air. The quantity of energy represented by q_{a_2}, is absorbed almost uniformly throughout the thickness of the inner glass, but the analysis can be greatly simplified, without appreciable loss of accuracy, by treating this energy as though it were released from a heat source located in the midplane of the inner glass. The temperature gradient from inside surface to the midplane would, therefore, be a straight line (neglecting the variation of thermal conductivity with temperature) based on transmission at a rate of q_i while the gradient from the midplane to the outer surface of the inner glass would be a steeper straight line based on the transmission at a rate of $q_i + q_{a_2}$ Btu/(hr)(sq ft). An equation can be written for heat transfer through the inner half of the inner glass,

$$q_i = \frac{t_{gi} - t_{gx}}{(r_g/2)} = \frac{2(t_{gi} - t_{gx})}{r_g} \quad \ldots\ldots (3)$$

and a similar equation for transmission through the outer half of the inner glass,

$$q_i + q_{a2} = \frac{t_{gx} - t_{g2}}{(r_g/2)} = \frac{2(t_{gx} - t_{g2})}{r_g} \quad \ldots\ldots (3a)$$

where t_{g_2} is the surface temperature of the outside of the inner glass. Adding Equations 3 and 3*a*,

$$2q_i + q_{a2} = \frac{2(t_{gi} - t_{g2})}{r_g} \quad \ldots\ldots (4)$$

An equation can also be written (similar to Equation 2) for the heat transfer from the outside surface of the inner glass,

$$q_i + q_{a2} = \frac{t_{go} - t_a}{r_a/2} \quad \ldots\ldots (5)$$

Substituting the equivalent inside film resistance, r_i, in Equation 2 places it in the same form as Equation 5,

$$q_i = (t_i - t_{gi})/r_i \quad \ldots\ldots (6)$$

Equations 4, 5 and 6 can now be solved simultaneously to eliminate the two unknown surface temperatures of the inner sheet of glass. From Equation 4,

$$t_{gi} = \frac{r_g}{2}\left(2q_i + q_{a2} + \frac{2t_{go}}{r_g}\right) \quad \ldots\ldots (4a)$$

and from Equation 6,

$$t_{gi} = (h_i t_i - q_i)/h_i \quad \ldots\ldots (6a)$$

Equating 4*a* and 6*a* and reducing,

$$2h_i t_i - 2q_i = 2r_g h_i q_i + h_i r_g q_{a2} + 2h_i t_{go}$$

and solving for t_{go},

$$t_{go} = t_i - q_i(r_i + r_g) - \frac{r_g}{2} q_{a2} \quad \ldots\ldots (7)$$

But from Equation 5,

$$t_{go} = \frac{r_a}{2}(q_i + q_{a2}) + t_a \quad \ldots\ldots (5a)$$

Eliminating t_{go} between equations 7 and 5*a* and reducing,

$$q_i = \left[\frac{(t_i - t_a) - \left(\frac{r_g}{2} + \frac{r_a}{2}\right)}{\frac{r_a}{2} + r_g + r_i}\right] q_{a2} \quad \ldots\ldots (8)$$

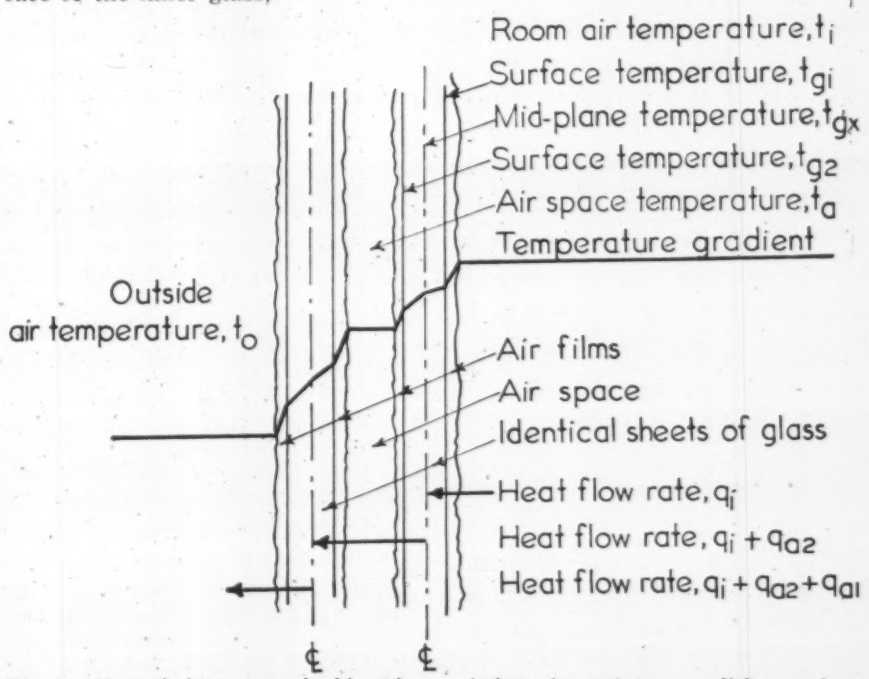

Fig. 3—Heat balance on double glass window for winter conditions when window is receiving solar radiation

But,

$$\frac{1}{\frac{r_a}{2}+r_g+r_i}=U_{g2} \quad \ldots\ldots\ldots\ldots\ldots (9)$$

where U_{g2} is the overall coefficient of heat transfer from room air to air space. Then substituting in Equation 8,

$$q_i=U_{g2}(t_i-t_a)-U_{g2}\left(\frac{r_g}{2}+\frac{r_a}{2}\right)q_{a2} \quad \ldots (10)$$

Note that the term $\frac{r_g}{2}+\frac{r_a}{2}$ in the above Equation 10, is equal to the thermal resistance from the midplane of the inner glass to the middle of the air space.

Equation 10 is not in a form satisfactory for use because it includes the unknown air space temperature, t_a. This term can be eliminated by writing an equation analogous to Equation 10 for the outer of the two sheets of glass, then solving the two equations simultaneously. Referring to Fig. 3, an equation similar to Equation 10 is,

$$q_i+q_{a2}=U_{g1}\ (t_a-t_o) - U_{g1}\left(\frac{r_g}{2}+r_o\right)q_{a1} \quad \ldots\ldots (11)$$

Solving Equation 10 for t_a,

$$t_a=\frac{\left[U_{g2}t_i-U_{g2}\left(\frac{r_g}{2}+\frac{r_a}{2}\right)q_{a2}-q_i\right]}{U_{g2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (10a)$$

and from Equation 11,

$$t_a=\frac{\left[U_{g1}t_o+U_{g1}\left(\frac{r_g}{2}+r_o\right)q_{a1}+q_i+q_{a2}\right]}{U_{g1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (11a)$$

Eliminating t_a between Equations 10*a* and 11*a* and reducing,

$$t_i-\left(\frac{r_g}{2}+\frac{r_a}{2}\right)q_{a2}-\frac{q_i}{U_{g2}}=\frac{(q_i+q_{a2})}{U_{g1}}+\left(\frac{r_g}{2}+r_o\right)q_{a1}+t_o \quad \ldots\ldots\ldots\ldots\ldots (12)$$

or,

$$q_i=\left\{t_i-\left(\frac{r_g}{2}+\frac{r_a}{2}\right)q_{a2}-\frac{q_{a2}}{U_{g1}}-\left(\frac{r_g}{2}+r_o\right)q_{a1}-t_o\right\}\frac{1}{\frac{1}{U_{g1}}+\frac{1}{U_{g2}}} \quad \ldots\ldots (13)$$

but,

$$U_c=\frac{1}{\frac{1}{U_{g1}}+\frac{1}{U_{g2}}} \quad \ldots\ldots (14)$$

where U_c is the overall coefficient of heat transfer for the window. Hence,

$$q_i=U_c(t_i-t_o)-U_c\left\{\left[\left(\frac{r_g}{2}+\frac{r_a}{2}\right)+\frac{1}{U_{g1}}\right]q_{a2}+\left(\frac{r_g}{2}+r_o\right)q_{a1}\right\} \quad \ldots\ldots (15)$$

But,

$$\frac{1}{U_{g1}}=r_o+r_g+\frac{r_a}{2}$$

so,

$$\frac{r_g}{2}+\frac{r_a}{2}+\frac{1}{U_{g1}}=r_o+1.5r_g+r_a$$

hence, substituting in Equation 15,

$$q_i=U_c(t_i-t_o)-U_c\left\{(r_o+1.5r_g+r_a)q_{a2}+\left(\frac{r_g}{2}+r_o\right)q_{a1}\right\} \quad \ldots\ldots (16)$$

Then substituting for q_i from Equation 2 and solving for q_h,

$$q_h=U_c(t_i-t_o)-\left\{U_c\left[(r_o+1.5r_g+r_a)q_{a2}+\left(\frac{r_g}{2}+r_o\right)q_{a1}\right]+q_t\right\} \quad \ldots\ldots (17)$$

The first term of Equation 17 is equal to the rate of heat loss that would occur if no solar effect were experienced. Thus one can write,

$$q_h=U_c(t_i-t_o)-\nabla' \quad \ldots\ldots (18)$$

where,

$$\nabla'=U_c\left[(r_o+1.5r_g+r_a)q_{a2}+\left(\frac{r_g}{2}+r_o\right)q_{a1}\right]+q_t \quad \ldots\ldots (18a)$$

and includes the entire solar effect. Equation 18 is, for unit irradiated area of a double window in which both sheets of glass are the same, but a similar equation can be readily developed for evaluating the term ∇' for a window with either less or more sheets of glass.

To evaluate the saving (or loss) of energy due to use of one square foot of irradiated window in place of an equal area of non-solar wall (the wall overall coefficient being U_w) subtract the excess transmission loss through the window from the ∇' term which represents net solar advantage. Thus,

$$\Delta q=\nabla'-(U_c-U_w)\ (t_i-t_o)\ \text{Btu/hr} \quad (19)$$

Since the term ∇' is independent of t_o it follows that a great simplifying advantage has been attained since the magnitude of the solar heat gain is constant (other conditions being the same) irrespective of the value of the outside air temperature. Note, therefore, that if a window is used for which the overall coefficient is identical with that of the replaced wall area the instantaneous rate of saving in energy requirements (for fixed solar conditions) would be the same for zero weather as for warm weather.

Seasonal Conditions

Equation 19 was developed for determining the instantaneous rate of saving corresponding to any given set of steady state conditions. Practical application of this equation would require that it be adapted to the determination of the actual quantitative saving expressed in Btu per heating season. Thus,

$$\Delta Q_{max}=\int_{season} E(\Delta q)d\theta=\sum_{season} E\nabla(\Delta\theta) - (U_c-U_w)\sum_{season}^{i}(t_i-t_o)\ \Delta\theta \quad \ldots (20)$$

where $\Delta\theta$ = a small increment of time

E = an *effectiveness factor* which accounts for partial shading (due to roof overhang) of the window.

The summation of Equation 20 is to be carried out over the entire heating season and the resultant ΔQ_{max} will be the saving available in a locality where the sun is never obscured.

If $\Delta\theta$ is taken as 1 hour and the heating season is considered to ex-

tend from October 1st to May 1st the number of $\Delta\theta$ intervals would be 5088 and Equation 20 would become,

$$\Delta Q_{max} = \sum_{n=1}^{n=5088} \nabla_n - (U_c - U_w) \sum_{n=1}^{n=5088} (t_i - t_{on}) \quad \ldots\ldots (21)$$

where $\nabla_n = E\nabla'$ –

A term t_o' can now be defined by the equation,

$$t_i - t_o' = \sum_{n=1}^{n=5088} \frac{(t_i - t_{on})}{5088} \quad \ldots\ldots (22)$$

giving, $t_o' = \sum_{n=1}^{n=5088} \frac{t_{on}}{5088} \quad \ldots\ldots (22a)$

Thus t_o' is the *average* outside air temperature during the heating season and its approximate value for any locality can be obtained from Table 1 (pp. 258-9) of the ASHVE GUIDE 1946. Equation 21 therefore simplifies to the form,

$$\Delta Q_{max} = \sum_{n=1}^{n=5088} \nabla_n - 5088\ (U_c - U_w)\ (t_i - t_o') \quad \ldots\ldots (23)$$

In its present form Equation 23 expresses the seasonal saving, in Btu, that would be attributable to 1 sq ft of glass if the sun were to shine for 100 per cent of the possible sunshine hours of the heating season. During the seven month heating period considered in this paper the maximum possible hours of sunshine (determined from data on the time of sunrise and sunset) are 2278 hours for latitude 40 deg and 2360 for latitude 35 deg. For many localities the weather bureau can provide information on the average number of actual hours of sunshine to be expected during a particular month and from this one can readily calculate the fraction of maximum possible time, for any locality, that the sun will be expected to shine. Table 1 gives fractions for a large number of American cities; values in the table were computed by dividing the average number of sunshine hours during a seven month heating season by the maximum possible hours as stated above; data on actual hours are taken from a recent article in *Heating and Ventilating*[1] which was developed from a weather bureau report.[2] The sunshine fraction is defined as the *usage ratio* and identified by the symbol F. With this substitution Equation 23 can now be written in a form which will give the *actual* seasonal saving in any locality,

$$\Delta Q = F \sum_{n=1}^{n=5088} \nabla_n - 5088(U_c - U_w)\ (t_i - t_o') \quad \ldots\ldots (23a)$$

If complete data were available on the distribution of actual sunshine hours through the day (for a given locality) the above Equation 23*a* could be given added accuracy by placing F under the summation sign and letting it represent the statistical fraction for a given hour rather than for the entire heating season. As the equation is now written the fraction of sunshine is necessarily treated as though it were the same for each hour of the day. Although such a uniform distribution does not actually occur, it is probable that for most localities the error introduced from this cause is not great.

Before proceeding with the evaluation of Equation 23*a*, a not inconsiderable problem remains; that is, to determine the seasonal solar effect as expressed in the summation $\sum \nabla_n$

The Solar Increment: Instantaneous Value

The solar term, defined in Equation 18*a*, relates three characteristics of the system; these are: (1) the solar transmission and absorption rates q_t, q_{a1}, q_{a2}; (2) the *effectiveness ratio, E,* which is defined as the fraction of the window which, at a given time, is not in the shade; (3) the thermal characteristics of the particular window as identified by the terms K_1 and K_2 *where,*

$$K_1 = U_c\left(\tau_o + 1.5\tau_g + \quad\right) \quad \ldots\ldots (24)$$

$$K_2 = U_c\left(\frac{\tau_a}{2} + \frac{\tau_g}{2}\right) \quad \ldots\ldots (25)$$

giving (by substitution into Equation 18a),

$$\nabla = E(K_1 q_{a1} + K_2 q_{a2} + q_t) \quad \ldots\ldots (26)$$

For a given type of window K_1 and K_2 have fixed values so ∇ is then a function only of E and of the three solar energy rates. Each of these rates depends on the physical characteristics of the glass, the angle of incidence and the solar irradiation. Each of these factors will be considered in some detail:

Glass Characteristics. When a sheet of glass is irradiated some of the energy is reflected, some absorbed and some transmitted. The characteristics of the glass which determine the distribution between these three forms of energy disposal are the thickness and the absorption coefficient, their product, KL, being the determining factor. For the

Table 1—Values of Usage Ratio, *F*, for Representative Cities.

[*F is ratio of the average number of sunshine hours in the period from October 1 to May 1 to the maximum possible sunshine hours (at the latitude of the city*[a]*) for the same period.*]

City	*F*
Albany, N. Y.	0.463
Albuquerque, N. M.	0.770
Atlanta, Ga.	0.522
Baltimore, Md.	0.553
Birmingham, Ala.	0.510
Bismarck, N. D.	0.546
Boise, Ida.	0.540
Boston, Mass.	0.540
Burlington, Vt.	0.419
Chattanooga, Tenn.	0.503
Cheyenne, Wyo.	0.666
Cleveland, O.	0.408
Columbia, S. C.	0.511
Concord, N. H.	0.515
Dallas, Tex.	0.470
Davenport, Ia.	0.539
Denver, Colo.	0.705
Detroit, Mich.	0.429
Eugene, Ore.	0.439
Harrisburg, Pa.	0.495
Hartford, Conn.	0.532
Helena, Mont.	0.521
Huron, S. D.	0.579
Indianapolis, Ind.	0.507
Jacksonville, Fla.	0.400
Joliet, Ill.	0.530
Lincoln, Neb.	0.614
Little Rock, Ark.	0.513
Louisville, Ky.	0.514
Madison, Wis.	0.504
Minneapolis, Minn.	0.527
Newark, N. J.	0.550
New Orleans, La.	0.370
Phoenix, Arizona	0.590
Portland, Me.	0.525
Providence, R. I.	0.542
Raleigh, N. C.	0.570
Reno, Nev.	0.637
Richmond, Va.	0.594
St. Louis, Mo.	0.567
Salt Lake City, Utah	0.592
San Francisco, Cal.	0.615
Seattle, Wash.	0.340
Topeka, Kans.	0.612
Tulsa, Okla.	0.560
Vicksburg, Miss.	0.447
Wheeling, W. Va.	0.408
Wilmington, Del.	0.558

[a] To facilitate use of Fig. 5 the F values are based on a denominator for either latitude 35 deg or latitude 40 deg. Thus, whereas the actual latitude at Tampa, Fla., is 28 deg the F value is based on 35 deg. This increases rather than decreases the accuracy when used with Fig. 5.

[1] Heat Gain From Winter Sunshine in the U. S., *Heating and Ventilating*, March 1946, pp. 63-66.

[2] *Atlas of American Agriculture*, Section B, Joseph B. Kincer, U. S. Weather Bureau.

purposes of this paper the only two kinds of glass considered were double strength A quality—with a *KL* value of 0.025—and clear ¼ in. plate glass with a *KL* of approximately 0.050. Using equations available in the literature,[3] the absorptivity, reflectivity and transmissivity were each determined as a function of angle of incidence. Likewise, the transmissivity was determined for windows made up of two identical sheets of glass, each sheet having a *KL* value of either 0.025 or 0.050 and the absorptivity determined for both the inner sheet and the outer sheet of these windows. Equations used for the window characteristics are modified forms of the equations derived in Parmelee's paper,[3]

$$T_{1,2} = T_1^2/(1-R_1^2) \quad \ldots\ldots (27)$$

$$A_{1 \text{ of } 2} = (1-R_1^2+R_1T_1)\left(\frac{A_1}{(1-R_1^2)}\right) \quad (28)$$

$$A_{2 \text{ of } 2} = \left(\frac{(T_1A_1)}{(1-R_1^2)}\right) \quad \ldots\ldots (29)$$

where T_1, A_1, and R_1 represent transmissivity, absorptivity and reflectivity, respectively; the subscript 1,2 indicates that the term is for the combination of two sheets of glass, whereas subscripts 1 of 2 and 2 of 2 identify the property as valid for the first of two sheets and the second of two sheets respectively; each of these properties varies as a function of the angle of incidence.

The Angle of Incidence, i, depends on the position of the sun and must, therefore, vary continuously throughout the heating season. At any given time this angle can be calculated from the solar altitude, the sun's azimuth and the orientation of the window. In this paper only windows located in walls facing south are considered and for this case the angle of incidence can be calculated from the equation,

$$\cos i = \cos H \cos (180-A) \quad \ldots\ldots (30)$$

or,

$$i = \cos^{-1}[\cos H \cos(180-A)] \quad \ldots\ldots (30a)$$

where i = angle of incidence of direct solar irradiation (measured from a normal to the window).

H = solar angle (from elevation of the sun above the horizon) determined from *Hydrographic Office Bulletin* 214.

A = sun's azimuth; measured in degrees east or west of north; determined from *Hydrographic Office Bulletins* 214 and 71

The Solar Intensity. The total solar intensity experienced on any vertical surface consists in part of an intensity, I_v, representing the component of direct solar radiation impinging on the surface and in part of an intensity, I_s, representing sky radiation and consisting largely of solar radiation which was scattered by dust and moisture during passage through the earth's atmosphere and is received diffusely at the surface rather than, as for direct radiation, as a solar beam. Because it is received from all directions, the transmissivity and absorptivity values applicable to sky radiation are independent of time and of latitude and have a fixed value for each particular type of window. Based on a graphical integration for diffuse irradiation, Parmelee[4] states that the integrated values of A_s and T_s can be considered equivalent to the specular values based on an incidence angle of 60 deg. Then for double glass windows, the absorptivity with respect to sky radiation is,

$$A_{s(1 \text{ of } 2)} = A_{1 \text{ of } 2} \text{ (for 60 deg)} \quad \ldots (31)$$

and $A_{s(2 \text{ of } 2)} = A_{2 \text{ of } 2} \text{ (for 60 deg)} \quad \ldots (31a)$

while the transmissivity of the combined two sheets of glass is,

$$T_{s1,2} = T_{1,2} \text{ (for 60 deg)} \quad \ldots\ldots (31b)$$

If, now, the q terms of Equation 26 are separated into direct solar and sky radiation fractions and are then replaced by their respective products of intensity and of absorptivity or transmissivity, the result is,

$$\nabla = E\Big[K_1(I_vA_{1 \text{ of } 2}+I_sA_{s\,(1of2)}) + K_2(I_vA_{(2 \text{ of } 2)}+I_sA_{s(2 \text{ of } 2)}) + (I_vT_{1,2}+I_sT_{s1,2})\Big] \quad \ldots\ldots (32)$$

where,

I_v = intensity of direct solar irradiation received on each square foot of irradiated window area,

I_s = intensity of sky radiation received on each square foot of irradiated window area.

Detailed attention must now be given to procedures for obtaining the instantaneous value of I_v and I_s.

Direct Solar Intensity. Basic to any discussion of solar effects is a knowledge of the irradiation intensity, expressed in Btu/(hr) (sq ft) on a plane normal to the sun's rays and located on the earth's surface. This intensity depends on the length of the path through the earth's atmosphere (determined by solar altitude), the character of the atmosphere (determined by dust concentration[5], ozone concentration and the quantity of water vapor[6]) and on variations in the intensity of solar radiation outside the earth's atmosphere. Extra atmospheric variation is due principally to seasonal variation in the distance of the earth from the sun; in this paper the variation has been taken as five units per month from a base value of the solar constant of 435 Btu/(hr)(sq ft) in January; the correction is subtracted both for the months that follow and for those that precede January.

Variations in length of path through the atmosphere can be readily expressed in terms of the solar altitude.

Variation of intensity at fixed solar altitude depends on the absorption characteristic of ozone in the earth's atmosphere, the scattering effect due to dust and to water vapor, the absorption effect of water vapor and, to a lesser extent, to the absorption effect of carbon dioxide. Analytical means of determining the intensity corresponding to a given dust and vapor concentrations are available in the literature[7] and where extremes of either humidity or dustiness (as most commonly evidenced by smokiness in the vicinity of industrial areas) are experienced a special solar analysis, for known local conditions, should be undertaken; in a subsequent paper the authors hope to develop graphical solutions of the solar problem which will include both water vapor and dust as variables and will thereby permit the designer to select conditions corresponding to the

[3]The Transmission of Solar Radiation Through Flat Glass Under Summer Conditions, by George V. Parmelee. (ASHVE JOURNAL SECTION, *Heating Piping & Air Conditioning*, October-November 1945.)

[4]Loc. Cit. Note 3.

[5]Review of U. S. Weather Bureau Solar Radiation Investigations, by Irving F. Hand. (*Monthly Weather Review*, Vol. 65, 1937, Table 12, pp. 441.)

Proposed Standard Solar Radiation Curves for Engineering Use, by Parry Moon. (*Journal of the Franklin Institute*, Vol. 230, No. 5, November 1940, p. 605.)

Turbidities of American Air Masses and Conclusions Regarding Seasonal Variation in Atmospheric Dust, by C. H. Wexler. (*Monthly Weather Review*, Vol. 62, 1934, pp. 397-402.)

[6]*Monthly Weather Review, Climatological Data Section*, Vol. 73, No. 1, Jan. 1945.

[7]Proposed Standard Solar Radiation Curves for Engineering Use, by Parry Moon. *Journal of the Franklin Institute*, Vol. 230, No. 5, Nov. 1940, p. 605.

actual atmosphere with which he is concerned. For the present, however, a procedure has been followed which is less exact, but is adequate for engineering purposes in most parts of the continental United States. Exceptions not subject to accurate treatment would occur in localities at high elevation or with very low or very high average winter dew points.

The recommended curve for direct solar intensity as a function of solar altitude is given in Fig. 1; similar curves for other months can be obtained by multiplying the intensity for January by the ratio of the solar constant for the month in question to the solar constant for January. The recommended curve was developed from theory[8] for a dust concentration of 300 particles per cubic centimeter (particles assumed uniformly 1 micron in size) and a vapor content corresponding to 33 F dew point temperature. The selected dust concentration is the same as that used by Moon[8] in developing his recommended intensity curve, but the dew point is substantially lower than the value used by Moon; this difference arises from the fact that Moon's curve is intended for summer use in calculating cooling load where as the recommended curve of Fig. 1 was specifically selected for use over the seven month heating season. Aside entirely from the theoretical considerations which entered into its development, the curve justifies itself by representing an effective, single line correlation of experimental intensity determinations. Representative experimental curves are shown in Fig. 4 which is for January and hence has 30 deg as the maximum solar altitude.

The solar intensity, I_o, given in Fig. 1, is for direct irradiation on a plane normal to the sun's rays. To obtain the irradiation, I_v, the normal intensity must be reduced to compensate for the greater vertical area corresponding to unit normal projected area. Thus,

$$I_v = I_o \cos i \quad \ldots\ldots (33)$$

Sky Radiation. The intensity of sky radiation, I_s, is influenced by the sun's position in two partially offsetting ways. As the angle of incidence becomes greater the value of I_o decreases, but the increased length of path through the earth's atmosphere promotes scattering and thereby tends to increase the amount of sky radiation. Only meager and inconsistent data are seemingly available on winter sky radiation, but the overall influence of this factor is relatively small so that possible gross inaccuracies in extrapolation of existing data will not seriously affect the overall solar radiation results. From an examination of available experimental information the curve of Fig. 2, giving the I_o/I_s ratio has been developed and is recommended for use during the seven month heating season for sky radiation impinging on a *vertical* surface. The sky radiation intensity is then,

$$I_s = \frac{I_o}{R} \quad \ldots\ldots (34)$$

where R is the ratio as read from Fig. 2. Particular attention is called to the fact that intensity of sky radiation is based on the normal direct solar intensity rather than on the value I_v which applies to a vertical surface.

Substituting from Equations 33 and 34 into Equation 32,

$$\nabla = E(I_o \cos i)\left[K_1\left(A_{1\text{ of }2} + \frac{A_{s\,1\text{ of }2}}{R \cos i}\right) + K_2\left(A_{2\text{ of }2} + \frac{A_{s\,2\text{ of }2}}{R \cos i} + T_{1,2} + \frac{T_{s\,1,2}}{R \cos i}\right)\right] \quad \ldots\ldots (35)$$

Equation 35 is difficult to work with. Calculation of numerical values of ∇ over a wide range of i shows that, *for the heating season*, neglect of the absorption fraction of sky radiation (but retaining the T_s term) will introduce an error in ∇ of approximately ½ of 1 per cent. This value is too small to be of practical significance hence Equation 35 can, with accuracy, be simplified to the form,

$$\nabla = E(I_o \cos i)\left[K_1 A_{1\text{ of }2} + K_2 A_{2\text{ of }2} + T_{1,2} + \frac{T_{s\,1,2}}{R \cos i}\right] \quad \ldots\ldots (36)$$

$$= E(I_o \cos i)\phi = EI_v\phi \quad \ldots\ldots (37)$$

where,

$$\phi = K_1 A_{1\text{ of }2} + K_2 A_{2\text{ of }2} + T_{1,2} + \frac{T_{s1,2}}{R \cos i} \quad \ldots\ldots (38)$$

The Effectiveness Ratio, E. In designing a building to permit maximum utilization of solar energy during the heating season a parallel requirement is to provide maximum exclusion of solar energy during the cooling season. Unfortunately these two design objectives are, in large measure, mutually irreconcilable. If sufficient roof overhang is provided to permit shading of the entire window at solar noon on June 21st the net result will inevitably be to shade a substantial fraction of the window at solar noon in February and in October, two months during which heating requirements may indicate the need of obtaining maximum solar irradiation. With any effective use of roof overhang there will necessarily be a reduction in available solar heating effect since a fraction of the window will often be in shadow.

In order to take account of this shading effect the square foot of glass used as a basis for the analytical treatment of this paper is considered to be a vertical strip of length depending on the amount of roof overhang, so located as to be

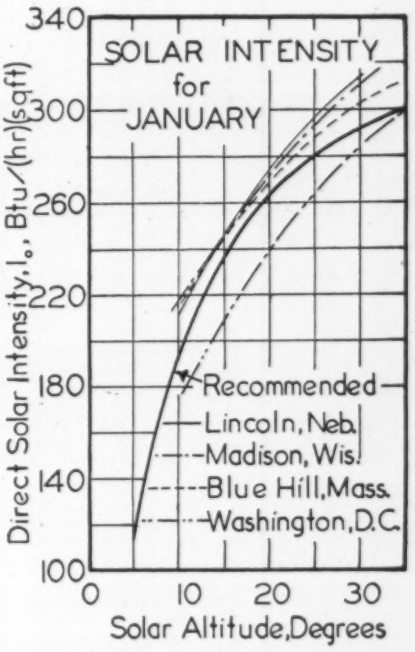

Fig. 4—Representative experimental values of direct solar intensity vs solar altitude

[8]Loc. Cit. Note 7.

fully in the shade at solar noon on June 21st, fully in the sun on December 21st and partially shaded at solar noon on all other days of the year. Both the dimensions of the strip and the height above the floor of the window sill will be fixed for any given amount of overhang, but for all windows which meet this prescribed condition the fraction of glass area in the shade at a particular day, time and latitude will necessarily be the same irrespective of window shape or area. This fraction, the E term, can be calculated —for any latitude, day and time— from a knowledge of the solar altitudes for that latitude at the day and time in question and at solar noon on the 21st of December and of June.

The Seasonal Advantage (or Loss) Due to Solar Heating

All required terms can now be evaluated and Equation 23a can, therefore, be solved by calculating the 5088 values of ∇_n which are needed to permit a seasonal summation. Formidable as this task may seem, it is not unduly difficult since more than half of the ∇_n terms will necessarily be equal to zero. The number of terms requiring evaluation is, therefore, reduced to something under 2500, the exact number varying with latitude and being numerically equal to the maximum possible hours of sunshine during the seven month heating season. Corresponding to latitudes 35 deg and 40 deg the maximum number of ∇_n terms are 2360 and 2278 respectively.

A further reduction can be attained by selecting one date as representative of average conditions during an entire month and by noting further that the average solar days of October and February are identical as are the average solar days of November and January. Thus a solar analysis of five days of the heating season, each day having approximately 10 possible hours of sunshine, will give data from which the 2360 ∇_n terms (for latitude 40 deg) can be evaluated. Even so, the task of calculating approximately 50 values of ∇_n for each latitude and for each type of window at each latitude is not a small one. The results presented in this paper are for two latitudes and four types of window, hence required computation of 400 basic ∇_n terms, including approximately 10,000 unit calculations.

Fig. 5 is a graphical solution of equation 23a based on values of $\mathbf{M}_{n=1}^{n=5088} \nabla_n$ which have been determined by tabular integration using the procedure developed in earlier sections of this paper. The solution given in Fig. 5 is as accurate as the assumptions which underlie the method.

Example: A window consisting of two identical sheets of ⅛ in. clear plate glass separated by a ¼ in. air space is to be used in a south wall which has an overall coefficient of heat transfer of 0.165 Btu/(hr) (sq

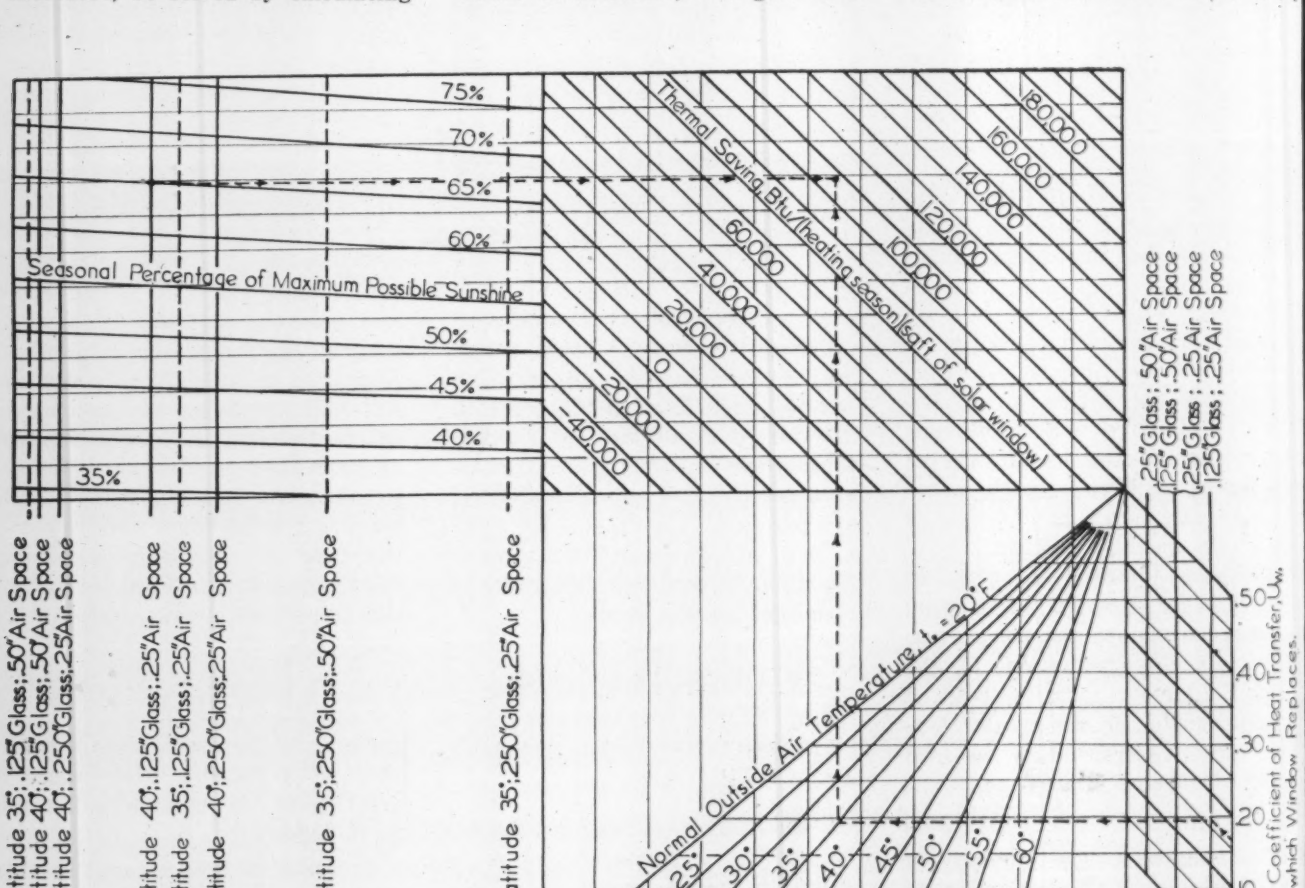

Fig. 5—Seasonal saving (or loss) attributable to 1 sq ft of double glass window replacing an equal area of south wall with solar overhang of roof

(Note that the opaque wall area is not credited with any effective seasonal solar energy utilization)

) (F). The normal outside temperature for the locality is 35 F and the sun shines for 65 per cent of the maximum possible hours between October 1 and May 1. Latitude is 40 degrees.

Solution: Enter bottom of the upper left quadrant of Fig. 5 at the heavy vertical line which is identified as applicable to ⅛ in. glass with ¼ in. air space at 40 deg latitude. Rise along this line to intersection with line for 65 per cent sunshine then move horizontally right (see dashed example line) to enter upper right quadrant. Now re-enter the figure at value of $U_w = 0.165$ on scale at right of lower right quadrant. Follow the directrix line from point of entry to intersection with vertical for ⅛ in. glass, ¼ in. air space, 40 deg latitude; then move horizontally left to intersect curve for $t_o = 35$ deg and from this point move vertically upward to intersect the horizontal line already established in the upper right quadrant. The point of intersection of these two lines gives the answer as 107,000 Btu saved per seven month heating season per square foot of window.

Summary

The gain (or loss) resulting from use of unit area of glass in place of unit area of wall is developed in terms of a rational general equation which gives the result in terms of the Btu saving per square foot of glass per heating season. The period adopted as a standard heating season is from October 1 to May 1; this choice permits determination from the ASHVE GUIDE of the normal outside temperature for this period in most parts of the United States. Table 1, based on Weather Bureau data, is included to give normal percentage of maximum obtainable sunshine that is experienced in 48 American cities during the heating period indicated.

Integrations of solar effects over the entire heating season are carried out for two latitudes and four combinations (of double glass with separating air space) of solar window; all cases considered are for windows located in walls facing south. Results of the analysis are shown graphically in Fig. 5; from this figure one can determine the seasonal gain (or loss) without calculation. Additional constants for use with east and west walls and in localities where atmospheric conditions are very unusual are being developed and will be presented, together with experimental results, in a later paper.

PRING MEETING OF ASRE

Pres. Charles S. Leopold greeted 0 members and guests who attended the 33rd spring meeting the *American Society of Refrigating Engineers,* which was held ne 3-5 at St. Paul, Minn., with e Twin Cities section of the soety acting as host.

In a luncheon address he used theme familiar to those who have en associated with him in *ASRE* tivities, stressing the need of man factors in all societies, inding the most scientific. In brief, defined the aims of the members the society as: "To promote the ts and sciences of refrigeration, d to have a good time doing it." e then pointed out the accomplishents of the *ASRE,* as evidence at the formula had worked.

The papers presented under the rection of the program chairman, r. D. K. Tressler, noted food technologist, covered a wide variety of bjects of interest to refrigeran engineers. Among the subjects scussed were: A New Psychroetric Chart, by D. D. Wile and E. Palmatier, Carrier Corp., which ovoked considerable discussion; e Control of Micro-organisms in od Storage Rooms, by Prof. W. Mallmann, Michigan State Colge; Technical Phases of Home eezer Development, by C. E. Lund, Seeger-Sunbeam Co.; and Heat Flow Through a Complex Structure, by Prof. Carl Kayan, Columbia University.

The Tuesday session was devoted to a symposium on air conditioning, at which this subject was discussed from the standpoints of high quality application practices, low maintenance, packaged applications, an analysis of multi-room systems, and standards for large space installations.

The grade of Fellow was added by the council to the present membership classifications of member, associate, and student member. This grade is available only to those who have belonged to the society for a period of 10 years or more, and meet at least five of twelve qualifications specified by the By-Laws.

An Invitation to Members

The Council wishes to encourage authors to contribute good technical papers for presentation to our Society, particularly papers dealing with new or novel developments. Good papers on air conditioning of all kinds and new papers on air distribution, industrial hygiene and industrial ventilation are of interest. A special committee has been appointed to secure papers. The membership of the Committee on Technical Papers is composed of G. L. Tuve, chairman; L. T. Avery, Walter Heibel, C. H. Flink, and Cyril Tasker.

Any one of the committee members will be glad to consult by mail or otherwise with authors to predetermine whether the particular paper is desired.

Papers must be presented first to the Publication Committee for approval for publication and then are passed on to the Meetings Committee for selection to use at the Annual or Semi-Annual Meetings. We need papers planned now to take care of the Annual Meeting in January 1947. If you have any papers you would like to suggest, please communicate with any of the committee members.

Air Conditioning a Canadian Windowless Textile Mill

By G. Lorne Wiggs*, Montreal, Que., Canada

SUMMARY—This paper describes the considerations governing the decision to construct a mill without windows. It describes the construction details with particular reference to the insulation of walls and ceiling, the air conditioning system and certain provisions which were made to permit economical expansion when this is required.

THE TREMENDOUS industrial expansion in Canada and the great engineering advances in both the textile machinery and textile mill construction fields in the United States during the war years have resulted in a new trend of textile mill design. Reflecting this recent trend is the new textile mill described in this paper.

The mill is located in the town of Ormstown, Que., situated approximately 40 miles southwest of Montreal. The mill was designed and constructed for producing spun rayon yarns, rayon and wool blends and worsted yarns on the latest type of machinery for handling long staple fiber. It will house a complete unit of 5000 spindles.

A perspective view of the new plant is shown in Fig. 1. It will be seen that the plant consists of a complete spinning mill, approximately 100 ft x 300 ft, which is a single story, completely windowless building, along the front of which are located the general offices, the men's and women's wash rooms, the first aid room, the cafeteria, the boiler room and the machine shop on the ground floor, with the executive offices on the second floor. A penthouse running practically the length of the mill houses all the air conditioning equipment. A covered loading platform with a railroad siding is also located along a portion of the front of the mill. An electrical substation and an artesian well and pump house are located at the back of the building. Probably the most striking thing about the plant is the small size of the chimney. The design was so made that by constructing additions at each end, the mill could readily be enlarged to increase the unit to one of 10,000 spindles. Further expansion could be made by building a second 10,000 spindle unit along the back of the present unit.

In designing a unit to produce the various yarns mentioned, the prime consideration was to design a building which would not only be an efficient operating unit but one in which the particular air conditions required for spinning each different yarn could be readily obtained at any time. Although the outdoor temperatures in this locality vary from a minimum of about –30 F in winter to a maximum of almost 100 F in summer and there is a very large concentrated internal sensible heat gain in the mill, the problem of designing the air conditioning system is not a particularly complex one. The difficulty lies in the determination of the best type of system to be used, in providing the proper air distribution so as to maintain a uniform temperature and humidity throughout the mill without objectionable draughts and in selecting equipment and controls to take care automatically of the widely differing conditions the system must encounter.

There was considerable difficulty in obtaining an authoritative statement of the exact air conditions which should be maintained in the mill for each different type of spinning. It was finally agreed, after consultation with the management and various authorities, that for spinning rayon yarns the air conditions to be maintained should be as follows:

Dry bulb temperature, 75 F to 80 F.

Relative humidity, 60 per cent to 65 per cent.

In spinning rayon and wool blends and spinning worsted yarns on the so-called French spinning system the air conditions required would be as follows:

Dry bulb temperature, 75 F to 80 F.

Relative humidity, 75 per cent to 80 per cent.

Since the mill is initially to spin rayon yarns and since it will probably be some years before rayon and wool blends or worsted yarns will be spun, the management decided to have the plant designed and constructed for the spinning of rayon yarns only, but to design the walls so that at a later date, when other yarns are to be spun, the additional insulation required in the walls to prevent condensation from occurring on these surfaces could be added. These considerations required a thorough study of many different possible types of wall and ceiling construction and of various insulating materials available, so as to produce an economical wall, especially when it is considered that at the time these studies were made many common building materials were extremely

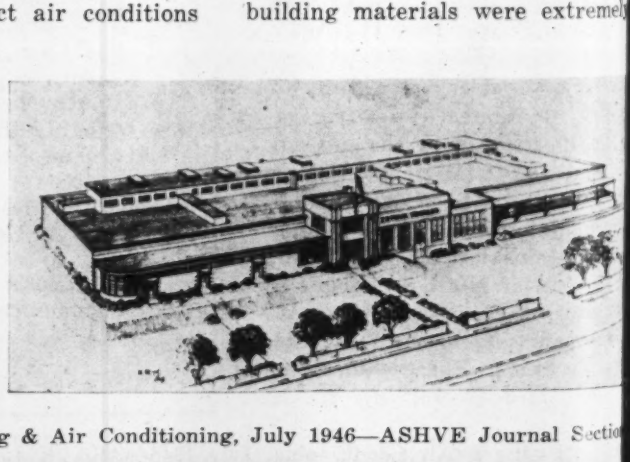

Fig. 1—Windowless textile mill

*Consulting Industrial Engineer. Member of ASHVE.

Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Montreal, Que., Canada, June 1946.

scarce in Canada and others were not available at all. The usual type of so called *Mill Construction* could not be adopted because of the shortage of lumber.

Reverting to the air conditions required in the mill when spinning rayon yarns, the following design conditions were adopted for the mill proper:

	Summer	Winter
Outside dry bulb temperature..	90 F.	—30 F
Outside wet bulb temperature..	73 F	.....
	Summer	**Winter**
Inside dry bulb temperature ..	75 F	75 F
Inside relative humidity	65%	65%
Inside wet bulb..	66.6 F	66.6 F
Inside dew point.	62.5 F	62.5 F

By reference to the graph, Fig. 4, Chapter 6 of the 1946 GUIDE, showing the permissible relative humidities for various transmission coefficients, it will be seen that for an outside temperature of –30 F, an inside temperature of 70 F, and a relative humidity of 65 per cent, the wall, roof or glass heat transmission coefficient U must be less than 0.20. The same graph shows that for an outside temperature of -30 F, an inside temperature of 70 F and an inside relative humidity of 80 per cent, the wall, roof or glass coefficient U must be less than 0.115. The coefficient U of single, double and triple thickness of glass being respectively 1.13, 0.45 and 0.281, it is obvious that for either of the above winter conditions, even if triple thicknesses of glass are used in the windows, condensation will occur on the glass whenever the outside temperature drops below 0 F. This, with the condensation which would occur on the window frames, would present a difficult problem when the relative humidity of the mill was maintained at 65 per cent and would be serious if the relative humidity were raised to 80 per cent. In addition, since the heat transmissions of glass windows or of glass bricks are all so much higher than those of well insulated walls, the omission of all windows materially reduces the cooling load in summer and heating load in winter and at the same time results in more uniform conditions in the mill. Because the omission of windows eliminates a difficult condensation problem and at the same time reduces the size of the air conditioning installation and the heating plant, it was decided to construct the mill proper without windows and with a minimum of exterior doors. However, in order to offset any possible objections that the plant employees might have to work in a completely windowless plant, windows were provided in the offices and service portion of the mill, where condensation is not a problem.

In order to allow for any possible lower temperatures at their inside surfaces, it was decided that the wall coefficient should initially be less than 0.15 and ultimately less than 0.10, while that of the roof should be less than 0.10.

After some study, it was decided to construct the plant with concrete foundations and a single reinforced concrete floor, with a structural steel frame, with exterior walls constructed of white brick bonded with 8 in. terra cotta blocks and with precast light weight aggregate concrete roof slabs, supported on steel bar joists, thus giving a fire resistant construction.

The many different insulating materials commonly used were then investigated. A number of desirable insulating materials were not available at the time. Finally it was decided to adopt for the exterior walls a slab insulating material made from shredded wood and cement, which has a conductivity k of 0.46 and which bears the approval of the Underwriters Laboratories. With a 2 in. thickness of this insulating material the value of U for the wall neglecting the interior finish is then approximately 0.14. When, at a later date an additional 2 in. thickness of insulation is added, the heat transmission coefficient U will be less than 0.09.

The insulating board has a rather rough finish, so that in order to obtain a smooth interior finish, it was decided to give the board a coat of neat cement plaster. After this was thoroughly dry, the plaster was given two coats of emulsified asphalt cement, in order to provide a satisfactory vapor barrier. As an additional seal and in order to prevent any possibility of the asphalt bleeding through the interior paint finish, the emulsified asphalt was given two coats of aluminum paint, which was finally painted with two coats of paint of a light green pastel shade.

The roof was insulated with wood fiber board insulation 2 in. thick which, with the light weight concrete roof slabs, gives a U value for the roof of less than 0.10. The inside surface of the roof was sprayed with two coats of emulsified asphalt to provide the neces-

Table 1—Tabulation of Heat Gains and Heat Losses

	Summer		Winter			
	Working Day	Week-End	Working Day		Week-End	
	Heat Gain	Heat Gain	Heat Gain	Heat Loss	Heat Gain	Heat Loss
Locker Room:						
Heat Transmission, Solar Heat Gain and Infiltration	9,800	9,800		99,900		99,900
Fan and Duct Heat Gain	8,900	8,900	8,900		8,900	
Internal Heat Gain	29,800		29,800			
			38,700	99,900	8,900	99,900
				38,700		8,900
Net Heat Gain or Loss	48,500	18,700		61,200		91,000
Carding & Drawing Room:						
Heat Transmission, Solar Heat Gain and Infiltration	78,100	78,100		822,200		822,200
Fan and Duct Heat Gain	25,400	25,400	25,400		25,400	
Internal Heat Gain	188,300		188,300			
			213,700	822,200	25,400	822,200
				213,700		25,400
Net Heat Gain or Loss	291,800	103,500		608,500		796,800
Spinning Room:						
Heat Transmission, Solar Heat Gain and Infiltration	62,600	62,600		656,900		656,900
Fan and Duct Heat Gain	81,100	81,100	81,100		81,100	
Internal Heat Gain	865,500		865,500			
			946,600	656,900	81,100	656,900
			656,900			81,100
Net Heat Gain or Loss	1,009,200	143,700	289,700			575,800

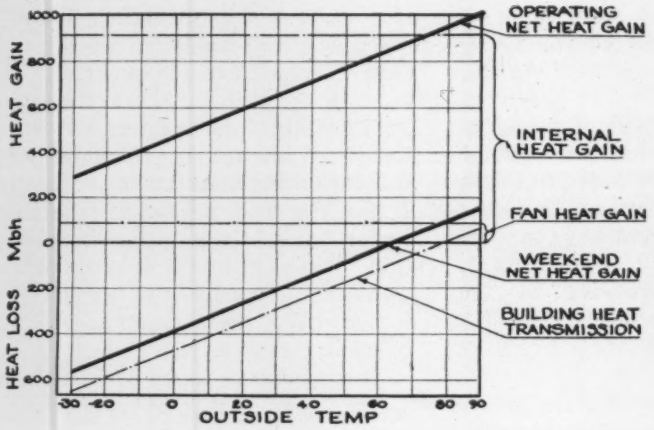

Fig. 2—Variation of heat gains and losses at various outdoor temperatures

sary vapor seal. Finally, a ceiling of gypsum board was attached to the bottom chords of the roof joists.

Incidentally, the roof of the mill was designed to be dead flat and the rain water leaders have been provided with removable standing waste pipes so that in summer the roof will be flooded with water approximately 2 in. deep.

The mill was designed so that its floor level would be at the level of a standard railway car floor which, due to the fact that the property is practically flat, meant that the mill floor is roughly 4 ft 5 in. above grade. The plant floor, the walls below floor level and the foundation walls were all constructed of reinforced concrete, the floor being 4 in. thick and the concrete walls 12 in. thick. The amount of exposed concrete wall was reduced by backfilling against the wall on all sides of the plant to a height of 3 ft 10 in. above the grade.

The wall and roof construction of the office and service section of the plant was modified slightly from that used in the mill proper, because the relative humidity to be maintained in this section of the plant is to be that commonly maintained in offices and the like.

The construction of the walls and the roof of the penthouse also are different from that of the plant, but were designed to have the same *U* value as those of the plant.

The mill proper is without windows of any kind and the only doors in the walls are those between the mill and the offices, one leading to the shipping platform and the regulation number of fire escape or panic doors. The panic doors were constructed similarly to standard refrigerator doors so as to minimize condensation on them and to prevent the doors from freezing in winter.

Having adopted the foregoing construction for the mill, calculations were then made to determine the various heat gains and heat losses of the mill for both summer and winter conditions.

Table 1 gives a list of the various heat gains and heat losses. It is notable that because of the large internal heat gains in the mill, particularly in the spinning room when it is in operation, even at –30 F, the spinning room requires cooling during the working days. The variation in the heat gains and heat losses in the spinning room at various outdoor temperatures are shown in Fig. 2. This graph is not strictly accurate, but it serves to show the relation between the various heat gains and heat losses for any given outdoor temperature. It might be mentioned that had the building been constructed with windows, the slope of the inclined lines would have been increased and both the maximum heat gain in summer and the maximum heat loss in winter would have been increased.

With the tabulation of heat gains and heat losses a study was made of the various types of air conditioning systems available, among these being the system having spray atomizers combined with mechanical ventilation, to provide both humidification in winter and evaporative cooling in summer and standard air conditioning systems, both central station type and unit type, to provide year round air conditioning. The unit air conditioning type was finally adopted, because of its flexibility, the ease of its installation and, particularly, because very little of the installation would be exposed in the mill. In order to expedite delivery and to keep costs to a minimum, eight standard unit conditioners were adopted for the mill proper, one being provided for the picker room, two for the carding and drawing room and five for the spinning room. A separate unit was provided for the offices and service areas. All the unit conditioners are factory assembled units, each including standard *capillary* cells, heaters, fan, pump, motors, etc. The unit conditioners are located as shown in Fig. 3. The outside air inlets to the units are located immediately above the units, while the entire penthouse acts as a return air plenum. The exhaust air is discharged outdoors through the wall of the penthouse. The conditioned air is supplied to the mill through conditioned air inlets of the type shown in Fig. 4, which also shows the continuous lighting troughs and the pendant automatic sprinkler heads. Since the spinning

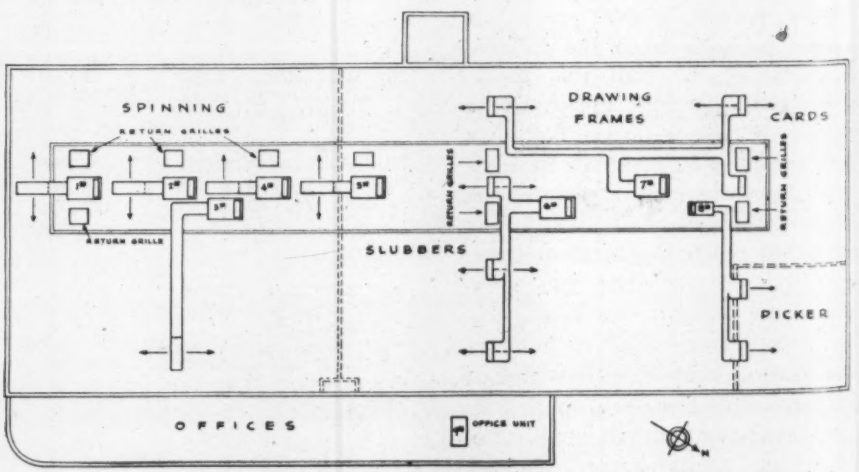

Fig. 3—Plan of mill showing location of air conditioning unit

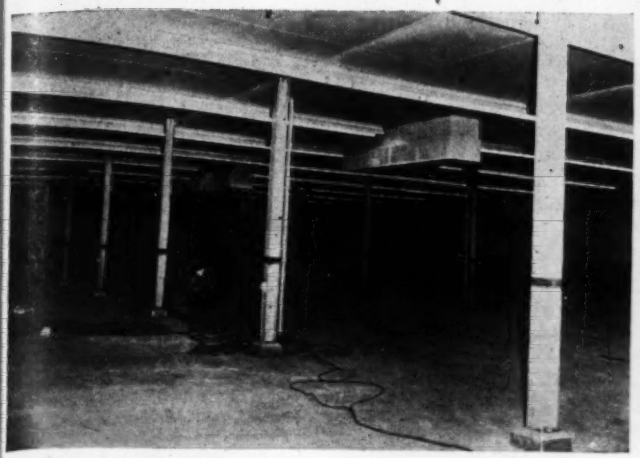

Fig. 4—Spinning room before installation of machinery

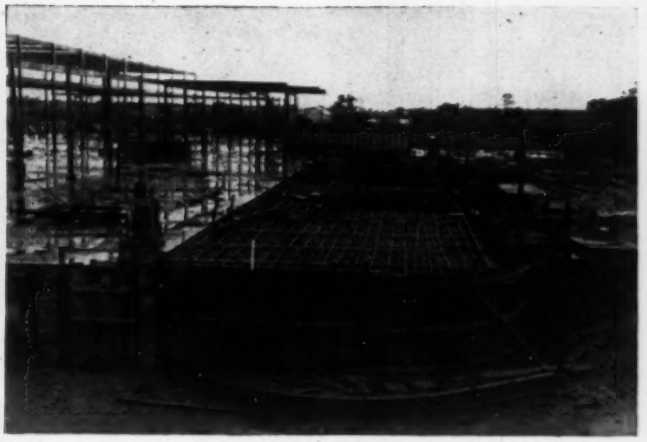

Fig. 5—Radiant heating coils before concrete was poured

frames will be driven by individual motors, there will be no overhead shafting or belts, with the result that the present clean cut appearance of the mill will be maintained even when the textile machinery is in place.

At the time that the mill was designed all refrigerating equipment was "frozen" in Canada. However, prices were obtained on the required refrigerating installation, including evaporative condensers, but at the same time a study was made of the few deep wells in the vicinity and of the geology of the locality. The geological surveys and reports available indicated that the ground in the area, under an overburden of about 60 ft of clay, had an underlying area of Nepean (Potsdam) sandstone formation of such a character and grain size that it could be expected to yield sufficient water at a reasonably low temperature to cool the plant.

Because of the uncertainty of obtaining refrigeration equipment, while a source of sufficient chilled water appeared to be available from a deep well, and because both the operating and maintenance costs of a deep well and of a deep well pump would be materially lower than that of a refrigerating unit, it was decided to sink a deep well 12 in. in diameter. The well was drilled to a depth of about 130 ft, of which about 65 ft is through clay and 65 ft is in bedrock. Later a pumping test of the well was made. After pumping continuously for 24 hours, the official 8 hour test showed a delivery averaging 827 U. S. gpm with a draw down of less than 20 ft. The temperature of the water was found to be 42½ F and, while its hardness was high, it was otherwise very satisfactory. As a matter of interest, the well drillers reported that they had run the test pump at various capacities to determine the ultimate capacity of the well, but they reached the limit of the capacity of the test pump at about 2500 U. S. gpm without seriously increasing the draw down of the well.

Based on a well water temperature of 45 F the quantity of chilled water required for cooling the plant and offices amounts to a total of 320 U. S. gpm. As a result, the well has not only ample capacity to cool the present mill, but will also be sufficient for cooling the future additions.

The heating of the mill proper will be done by means of steam heating coils in the unit conditioners, while the heating of the offices and service areas will be provided by a low temperature radiant panel heating installation in the concrete floors of those areas. The partly fabricated floor coils are shown in Fig. 5. The radiant heating system utilizes forced hot water as a heating medium. In order to prevent the possible occurrence of condensation on the concrete floor of the mill proper, along its junction with the foundation walls, a single pipe coil was built into the junction of the exterior walls and the concrete foundations. The coil is connected to the radiant heating system. A detail showing just how this coil was built into the wall is shown in Fig. 6. The boiler plant consists of two oil fired low pressure steam boilers, which provide steam for the heating of the plant and for heating the domestic hot water. Each boiler has a rated heating capacity of 4500 sq ft EDR when mechanically fired. When the textile machinery is in operation one boiler only will be used, even during the coldest weather, but both boilers will be required during the week-ends when subzero temperatures occur. It is due to the fact that the plant is windowless that such a small boiler capacity is required and that consequently the size of the chimney is so small in comparison to those usually found on mills of similar size. It is planned that at a later date electric heaters will be installed in the conditioned air supply ducts so as to take care of the weekend heating. In this way the steam boilers will be used during the plant operating periods only and the heating during the weekends will be done by electricity purchased as off peak power. Thus the present steam boilers will have sufficient capacity to take care of the heating of the future additions to the mill.

Because so little heating will be required in the mill, the fuel oil burning installation adopted utilizes oil burners approved to burn No. 4 fuel oil.

A schematic diagram of the control system for a typical factory air conditioning unit is shown in Fig. 7. This control system was designed to hold the dry bulb temperature and relative humidity constant the year round, and to control automatically the heating and humidi-

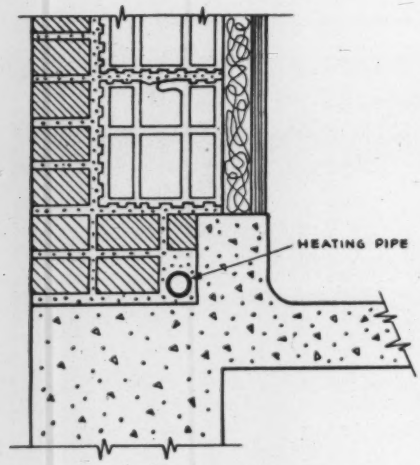

Fig. 6—Detail of single heating coil in exterior wall

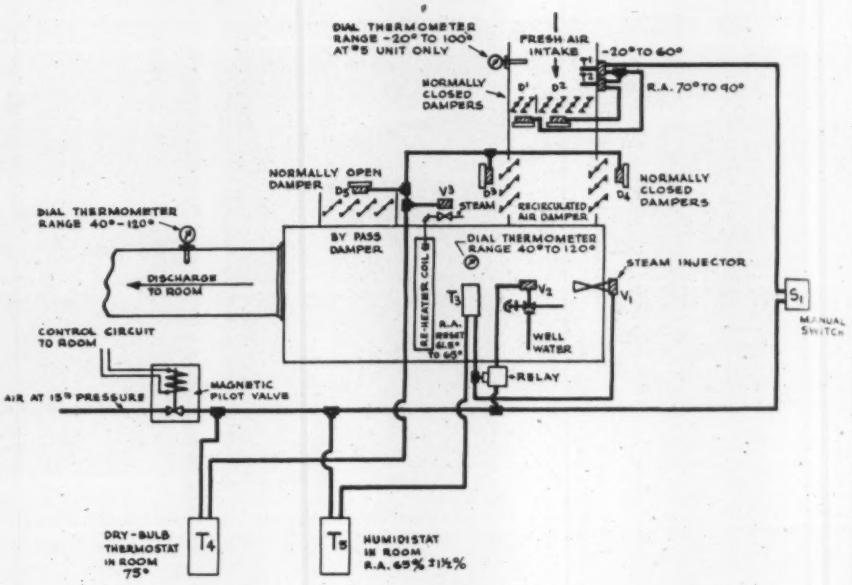

Fig. 7—Schematic diagram control system for a typical factory air conditioning unit

fication in winter, the evaporative cooling in spring and fall and the cooling by well water in summer.

Due to delays caused by difficulty in obtaining materials and by strikes both in the construction industry and, particularly, in the textile machinery manufacturing industry, this mill has not yet been put into production. It is, therefore, impossible at this time to give any data regarding its operation. After the mill has been in operation for some time, it is planned to make a survey of the performance of its air conditioning installation similar to surveys now being made by the writer in a number of other textile mills and it is expected that the comparative data thus accumulated would form the basis of a subsequent paper.

PROF. GIANNINI NAMED EXECUTIVE ASSISTANT OF ENGINEERING COLLEGE

Prof. Mario C. Giannini, associate professor of mechanical engineering and director of the evening division of the College of Engineering of New York University, was appointed executive assistant of the College of Engineering, as announced by Chancellor Harry Woodburn Chase.

Professor Giannini became a member of the University faculty in 1926. He is a member of the metropolitan committee, National Fuel Efficiency Program, U. S. Department of Interior; Board of Engineers, manpower utilization committee of the War Manpower Commission; *Society for the Promotion of Engineering Education;* the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and vice-president of the New York chapter of the Society; he was recently appointed ASHVE representative on the *ASA* Sectional Committee B-53, Refrigeration Nomenclature, and chairman of the Special Society Committee to cooperate with other professional societies.

M. C. Giannini

He has served as a consulting engineer in heating, air conditioning and mechanical equipment of buildings and as a consultant to publishers on engineering and technical textbooks. He is an adviser to the division of general education of New York University on vocational-technological training.

He is a graduate of the University of Michigan and was formerly associated with Nash-Kelvinator Corp., United Wall Paper Factories and Booz Allen & Hamilton.

ESTEP APPOINTED ASSISTANT TO PRESIDENT

Leslie G. Estep, a member of the Society for the past 10 years, was appointed assistant to the president of Spiegel, Inc., as announced by M. J. Spiegel, president. Mr. Estep will be responsible for personnel, organization and policy development and branch plant development.

JORDAN EXECUTIVE SECRETARY

Dean Frederick M. Feiker, chairman, division of engineering and industrial research, National Research Council, has announced the appointment of Louis Jordan as executive secretary of the division.

Mr. Jordan was for many years a member of the staff of the metallurgical division of the National Bureau of Standards; has served as assistant secretary of the *American Institute of Mining & Metallurgical Engineers* and as executive secretary of the metals division of the *AIMME*. He was on the staff of the War Production Board, and in January, 1942, came to the National Research Council, being responsible, throughout World War II, for the administrative organization and operation of the War Metallurgy Committee in all of its activities as an advisory committee to WPB in the fields of minerals and metals research and development.

Reprints of ASHVE Papers

There are available in the files of the Society many reprints of papers which have appeared in its JOURNAL and TRANSACTIONS. For those who wish copies they can be obtained, while the supply lasts, from Society Headquarters, 51 Madison Ave., New York 10, N. Y., at a nominal cost (25 cents each for single copies).

Air Cleaners and Washers, Dust and Dust Removal, Air Pollution and Purification, Air Sterilization

Adaptability of Pre-Cooling Coils to Air Washer Systems, by John Everetts, Jr.—1937

Air Filter Performance as Affected by Kind of Dust, Rate of Dust Feed and Air Velocity Through Filter, by F. B. Rowley and R. C. Jordan—1938

Air Filter Performance as Affected by Low Rate of Dust Feed, Various Types of Carbon, Dust Particle Size and Density, by F. B. Rowley and R. C. Jordan—1939

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Alternate Method of Comparing Dust Arrestance of Air Cleaning Devices, by Arthur Nutting—1937

Carbon Monoxide Distribution in Relation to the Ventilation of a One-Floor Garage, by F. C. Houghten and Paul McDermott—1932.

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Control of Industrial Atmospheres, by W. N. Witheridge—1945

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Determining the Quantity of Dust in Air by Impingement, by F. B. Rowley and John Beal—1929

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Part 2—The Use of Fuel Consumption and Equipment Data in the Abatement of Atmospheric Pollution, by Arthur C. Stern
Part 3—Sootfall Studies for New York City, by Jac Siegel and Benjamin Feiner
Part 4—Suspended Particulate Matter in New York City Air, by Benjamin Feiner and Jac Siegel

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A Study of Heating and Ventilating Conditions in a Large Office Building, by C.-E. A. Winslow and G. F. Maglott—1915

Ventilation of the Capitol, Washington, D. C., by N. S. Thompson—1911

Transportation Heating, Ventilating and Air Conditioning

Heating and Ventilating for Transport Airplanes, by B. M. Brod—1946

Train Piston Action Ventilation and Atmospheric Conditions in Chicago Subways, by W. E. Rasmus and Edison Brock—1944

Warship Ventilating, Heating and Air Conditioning, by T. H. Urdahl and W. C. Whittlesey—1943

Unit Heating and Ventilating

Design and Performance of a Direct-Fired Unit Heater, by R. M. Rush and H. A. Pletsch—1942

Heat and Air Volume Output of Unit Heaters, by L. S. O'Bannon—1929

Suggested Method of Testing Unit Heaters Suitable for Field Use, by L. S. O'Bannon—1930

Ventilating Standards

Air Supply to Classrooms in Relation to Vent Flue Openings, by F. C. Houghten, Carl Gutberlet and M. F. Lichtenfels—1942

Chemical Notes on Ventilation, by P. N. Evans—1912

Noise and Ventilation, by G. T. Stanton—1931

Noise Reduction in Ventilating Units, by Warren Ewald—1931

Objectives and Standards of Ventilation, by C.-E. A. Winslow—1926

Open Windows with Mechanical Ventilation, by R. C. Taggart—1912

An Outline of the Activities of the New York State Commission on Ventilation for the Year 1915, by G. T. Palmer—1916

A Rational Basis for Ventilation, by J. E. Rush—1926

Recent Advances in Psysiological Knowledge and Their Bearing on Ventilation Practice, by C.-E. A. Winslow—1939

Report of the Committee on Legislation for Compulsory Ventilation—1912

Report of Work on Ventilation Division of Chicago Health Department, by E. V. Hill—1914

Sanitary Ventilation, by W. F. Wells—1942

The Value of Good Ventilation, by Severance Burrage—1911

Ventilation Division, Chicago Board of Health, by E. V. Hill—1913

Ventilation Problems, by D. D. Kimball; The Hygiene of Ventilation, Discussion by Invited Guests of the Society—1912

Ventilation Requirements (Part II), by C. P. Yaglou and W. X. Witheridge—1937

Ventilating Systems

Car Ventilation, by D. I. Cooke—1914

Dairy Stable Ventilation, by F. L. Fairbanks—1928

Development of the Ventilation System of the Holland Tunnel, by A. C. Davis—1931

Mine Ventilation and Its Relation to Health and Safety, by D. Harrington—1945

School Room Ventilation, by A. C. Willard—1928

Street-Car Ventilation, by W. Thorn—1911

Ten Fundamentals of Unit Ventilation and Their Application, by A. J. Nesbitt—1927

The Ventilation of Sleeping Cars—Comparative Tests of Various Types of Exhaust Ventilators, by T. R. Crowder—1915

Ventilation of Telephone Booths, Including Other Applications of Small Unit Sets, by R. L. Douglass—1914

Ventilation of the Debating Rooms of the New Kiksdages Building in Stockholm, by Wilhelm Dahlgren—1906

Miscellaneous

Application of High Temperature Liquid as a Heat or Energy Transfer Medium for Domestic and Industrial Uses, by O. C. Oaks—1946

Comfort in High Altitude Flying, by D. W. Tomlinson—1941

Concerning Conservation of Underground Water with Suggestions for Control, by N. F. Porter—1941

Description and Performance of Two Heat Pump Air Conditioning Systems, by Philip Sporn and E. R. Ambrose—1944

Design and Equipment of the Pierce Laboratory, by C.-E. A. Winslow, Leonard Greenburg, L. P. Herrington and H. G. Ullman—1934

Development of the Art of Heating and Ventilating in Canada, by L. M. Arkley—1926

Developments of 1930 in Heating and Ventilating, by S. R. Lewis—1930

The Education of Heating and Ventilating Engineers, by J. D. Hoffman—1904

Engine Condensation, by Perry West—1915

Expense of Operating Heating and Ventilating Plants, by H. M. Hart—1913

Field Study of Comfort Reactions of Apartment Dwellers Under Fuel Oil Rationing, by Sallye Hamilton—1943

Fifty Years in Heating and Ventilation, by S. R. Lewis—1944

Final Values of the Interaction Constant for Moist Air, by John A. Goff, J. R. Anderson and S. Gratch—1943

Heating and Ventilating of Cars, by E. R. Swan—1907

Heating and Ventilating Problems of Gas Cell Manufacture for Air Ships, by D. E. Humphrey—1928

Heating and Ventilation of a Modern Steam Power Station, by D. S. Boyden and A. B. Williams—1925

Heating a Swimming Pool, by C. Teran—1912

Heating Industry in Canada, by N. A. Hill—1914

Heating in Turkey, by J. R. Allen—1912

Hydro-Electric Power Compared with Steam, by R. P. Bolton—1914

The Heating Value of Exhaust Steam, by D. M. Myers—1915

The Interaction Constant for Moist Air, by J. A. Goff and A. C. Bates—1941

Low-Pressure Properties of Water from —160 to 212 F, by John A. Goff and S. Gratch—1946

Medical and Public Health Aspects of Heating Oil Rationing, by Leverett D. Bristol—1942

A Method of Heating a Corrugated-Iron Coal Preparation Plant, by E. K. Campbell—1944

The Metric System, by C. F. Hauss—1904

Notes on the Use of Feed Water Heaters in Connection with Heating Systems, by W. G. Snow—1906

Performance Characteristics of a Forced Draft Counterflow Spray Cooling Tower, by H. H. Niederman, E. D. Howe, J. P. Longwell, R. A. Seban and L. M. K. Boelter—1941

Power from Process and Space Heating Steam, by L. A. Harding —1930

Progress in Air Conditioning in the Last Quarter Century, by W. H. Carrier—1936

Progress in Heating and Ventilating During the Past Quarter of a Century, by R. P. Bolton—1931

Recent Developments in Absorption Refrigeration, by Glen Miller —1941

Reheating by Means of Refrigerant Compressor Discharge Gas, by S. F. Nicoll—1941

The Relation of the Force of Gravity to Some of the Economics of Heating, by J. M. W. Kitchen—1907

A Review of Some Heating Literature, by H. J. Barron—1904

Therapeutic Uses of Low Temperature, by Frederick M. Allen—1945

Thermodynamic Properties of Moist Air, by John A. Goff—1945

The Thermo-Integrator—A New Instrument for the Observation of Thermal Interchanges, by C.-E. A. Winslow and Leonard Greenburg—1935

Sheet Metal Radiation, by H. W. Nowell—1905

Time Analysis in Starting Heating Apparatus, by R. C. Taggart —1913

The Time Element in Heating Apparatus, by J. A. Donnelly—1912
Vapor Pressure of Ice from 32 to —280 F, by J. A. Goff—1942

Control of Solvent Vapor Exposure*

There are three general methods of approach to the problem of protecting the worker against toxic concentrations of solvent vapors. These three methods are commonly used throughout the field of industrial hygiene and have application in the present instance. They are:

1. Substitution of less toxic solvents.
2. General ventilation, that is, dilution of the general workroom atmosphere with uncontaminated air.
3. Local exhaust ventilation, that is, removal of contaminants at their source.

Examples of the application of two of these methods will be discussed briefly:

1. Substitution:

There is the possibility of the use of solvents which are relatively non-toxic as substitutes for solvents of higher toxicity in rubber cements. The choice is not unlimited since some of the rubbers, neoprene for example, are not readily soluble in the least toxic organic solvents.

Chlorinated hydrocarbons such as carbon tetrachloride and trichlorethylene were not encountered in any of the cements seen in the shoe survey. When benzol was found present, and a number of such cements with amounts of benzol up to 50 per cent by volume of the solvent were found being used, the dangers to workers inherent in the inhalation of benzol vapor were explained to the management. In every case, the owner or plant superintendent was amazed that such material could be sold at all. Labeling, when used, was very inconspicuous so that the plant management was unaware of the presence of benzol in the cement used. The result in each case was substitution of a substantially benzol-free (less than 5 per cent) for the one with more benzol. In most cases, the same cement supplier was able to furnish a satisfactory cement which was substantially benzol-free, indicating the relative ease with which the dangerous benzol could be replaced by other adequate solvents with much lower toxicities.

As previously noted, aromatic hydrocarbons such as toluol, mixtures of toluol and petroleum naphtha in the form of aromatic petroleum naphtha, type I, and naphthenes (especially cyclohexane) mixed with toluene or with aromatic petroleum naphtha make good solvents for neoprene and have much lower toxicities than benzol.

There is no excuse for having benzol present in Buna S or reclaimed natural rubber cements since these two types of rubber are soluble in petroleum naphtha alone.

Another substitution which involves little or no exposure to organic solvents and a slight, if any, exposure to ammonia gas, is the use of latex. Latex before the war consisted of an aqueous dispersion of natural rubber. The milk-white fluid was the sap of the rubber tree with added preservative to prevent coagulation. Present latex is an aqueous dispersion of synthetic rubber particles. This latex comes directly from the reactor in which the rubber has been produced. Preservative (usually ammonia) and/or alcohol, may be added. Objection to the use of latex is raised because of its water content. This may cause fabric to which it is applied to wrinkle or shrink. On the other hand, it and other water soluble adhesives are being used successfully in certain types of footwear.

2. General Ventilation:

If cementing is performed in large rooms with good air movement, considerable dilution of the solvent vapors will occur so that concentrations to a toxic level may not be built up in the workroom air. Dilution due to the large volume of room air which is present may be increased by the use of mechanical general ventilation in which additional air is brought into the room, preferably at ceiling level, and the contaminated air is withdrawn from the room, preferably at floor level, and discharged to the outdoors. This procedure has been found especially applicable in the construction of certain articles made with synthetic rubbers for war purposes.

Table 1 indicates the quantity of air which must be brought into a room or be provided by existing room volume to dilute the vapor from a gallon of each of the solvents listed to the maximum permissible concentration in air listed when that gallon of solvent is completely evaporated. This is, however, predicated on uniform and complete homogeneity of atmospheric concentration of the solvent vapor. Such is usually difficult to attain and vapor concentrations in the vicinity of workers using the solvents are as a rule higher than in areas of low activity. For this reason, a larger volume than indicated in the table, usually four to five fold, should be used for proper dilution.

Table 1—General Ventilation Requirements

Solvent	Maximum Permissible Concentration for Prolonged Exposure	Volume of Air Required for Dilution of Vapor from One Gallon of Solvent So That Its Concentration is Equal to Max. Permissible Conc.
Petroleum naphtha (as hexane).	1,000 ppm	25,000 cu ft
Benzol	50	700,000
Toluol	400	75,000
Xylol	200	135,000
Naphthenes (as cyclohexane)...	400	75,000
Acetone	1,000	45,000
Methyl ethyl ketone	500	75,000
Carbon tetrachloride	75	435,000
Trichlorethylene	200	185,000

*Abstracted from N. Y. State Dept. of Labor, Division of Industrial Hygiene and Safety Standards, *Monthly Review*, Vol. 25, January 15, 1946

(Left to Right): Carl H. Flink, Technical Secretary; Walter L. Fleisher, President—1941; Mr. Hutchinson; Pres. Alfred J. Offner; R. H. Carpenter, Council 1930-35; Harold J. Ryan, President, New York Chapter

In Recognition of 20 Years as ASHVE Secretary

On June 5, Pres. Alfred J. Offner, accompanied by W. L. Fleisher, past president of the Society; R. H. Carpenter, former member of Council; H. J. Ryan, president of New York Chapter, and Carl H. Flink, technical secretary, met at the headquarters office of the Society and presented a handsome silver platter to Secretary A. V. Hutchinson. The inscription read: *"Presented to A. V. Hutchinson, January* 1946, *by the members of the A. S. H. V. E. in appreciation of his twenty years as National Secretary."*

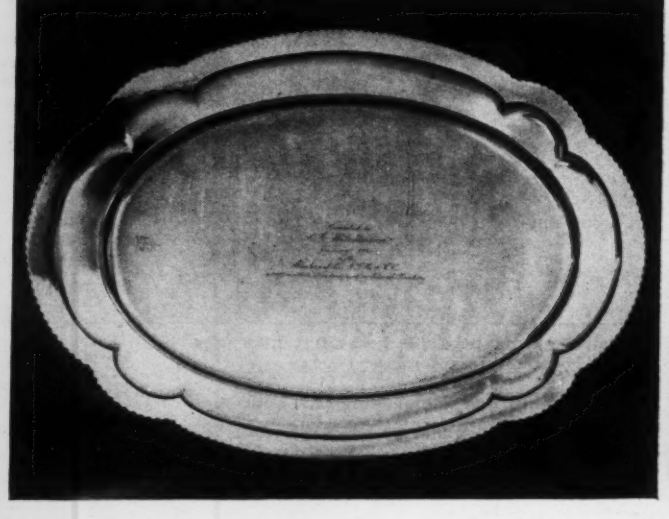
In his tribute to Secretary Hutchinson's services, Mr. Offner said:

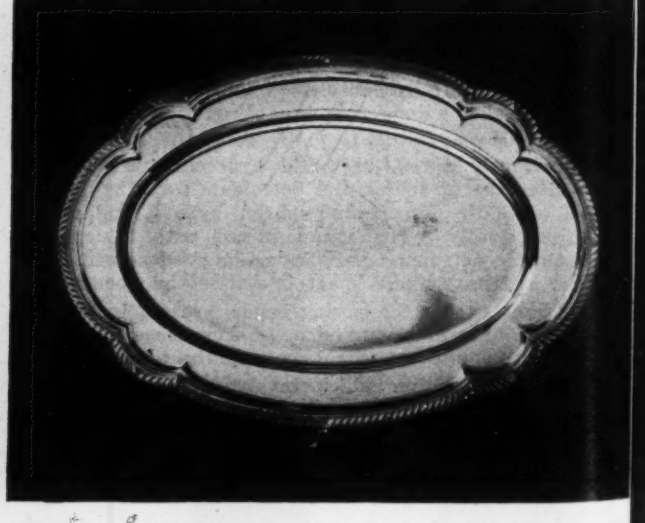
"The year 1922 was an eventful year for the Society in many ways, it was the year that the first GUIDE was published. It was also the year that the Society was so fortunate as to obtain the services of a modest young man as manager of publications. Three years later, to fill the vacancy created by the transfer of Secretary F. C. Houghten to Pittsburgh as Director of the ASHVE Research Laboratory, the young man I am speaking about became Acting Secretary and the following year Secretary. By this time you should know that I am speaking of A. V. Hutchinson, affectionately known as "Hutch" to us who have known him for so many years and know of his work, his guidance and help and his untiring labor for the Society.

Mr. Hutchinson has now completed twenty years of faithful service as our Secretary. During this time the Society has tripled in membership, from 1500 to over 4700; the number of chapters has increased from 14 to 38; he has made arrangements for 20 Annual Meetings, 19 Semi-Annual Meetings, 3 Regional Meetings and many special meetings in various parts of the United States and Canada. He has travelled many thousands of miles for the Society, including over 200,000 miles by air.

The years have not only increased his work for the Society but also the duties and importance of his efforts as Secretary. He has done a fine job. Therefore, it is not only proper but also fitting that we, the members of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, pay tribute to him on this occasion. As president of the Society it is not only a pleasure but also an honor for me to present to you, Secretary Hutchinson, this token of the Society's appreciation and esteem of your faithful services."

In response Mr. Hutchinson expressed his sincere thanks for the special honor accorded him.





ANNUAL MEETING AND EXPOSITION IN CLEVELAND

At the June meeting of the Council held at the Mount Royal Hotel, Montreal, June 10, a discussion of the program for the 53rd Annual Meeting of the Society to be held in Cleveland, January 27-31, 1947, indicated that the main topics of discussion would cover the important subjects of air conditioning and industrial ventilation, panel heating, air distribution and warm air heating.

A report on the 7th International Heating and Ventilating Exposition to be held January 27-31 at Lakeside Hall, concurrently with the Society's meeting and the mid-winter meeting of the *National Warm Air Heating and Air Conditioning Association*, indicated that 90 per cent of the total exhibit area had been engaged by leading manufacturers of heating, ventilating and air conditioning equipment, assuring an exceptionally comprehensive display.

This will be the first Exposition of its class since 1940, and the most stimulating and informative in the 17 years since its inauguration. During the war all the energies and facilities of this important segment of the nation's industries were at the disposal of the Government and with the reconversion to independent status a great number of innovations in unit design and construction are being activated.

In addition to former exhibitors, a group of new manufacturers of heating, ventilating and air conditioning equipment has entered the field.

The Exposition will be under the direction of Charles F. Roth, president, International Exposition Co., and E. K. Stevens, associate manager.

An Advisory Committee of professional and industrial leaders will serve under the chairmanship of Alfred J. Offner, president of ASHVE.

The Committee on Arrangements for the Northern Ohio Chapter of the Society is planning the entertainment program which is being developed under the direction of L. L. Taze, chairman.

The feature of this Annual Meeting will be the inspection of the Society's new Research Laboratory at 4218 Euclid Ave. This will afford members the first opportunity of seeing the new facilities for research and becoming acquainted with the program which is being carried out and upon which there will be reports at the technical meetings.

NOMINATIONS INVITED

The Committee of Award for the F. Paul Anderson Medal will receive nominations until August 15, 1946.

The F. Paul Anderson Medal is awarded to a member of the ASHVE "in recognition of notable scientific achievement or for outstanding service performed in the field of heating, ventilating or air conditioning."

Nominations should be addressed to the Committee of Award for the F. Paul Anderson Medal at the headquarters of the Society, and should be accompanied by a detailed statement indicating the specific achievement or service performed.

Since the establishment of the F. Paul Anderson Award in 1930 medals have been presented to six members whose services have been outstanding in the field of heating, ventilating and air conditioning.

The Committee will carefully consider nominations and will submit its recommendations to the Council at the final Council Meeting of the calendar year.

B. M. Woods, *Chairman*
R. H. Carpenter
W. H. Driscoll
E. O. Eastwood
F. E. Giesecke

VIRGINIA CHAPTER RECEIVES CHARTER

The newly organized Virginia Chapter held its charter meeting in Norfolk on May 22 and the charter granted by the Council was presented by Alfred J. Offner, president of the Society, to the chapter president, R. C. Thomas. President Offner made a brief talk about the general activities of the Society and stressed the importance of local chapter activities in stimulating the Society's work.

C. A. McKeeman, assistant to the president, gave a resume of the Society's research activities and emphasized the value of fundamental research work being carried on at the Laboratory in Cleveland.

A report of the chapter nominating committee was presented and the election of permanent officers resulted as follows: *President*, R. C. Thomas; *Vice-President*, W. H. Webster, Jr.; *Treasurer*, W. G. Hayes; *Secretary*, J. F. Reynolds. *Board of Governors*—W. G. Gorsuch, W. P. Robinson and J. E. White.

WALTER B. MOSES, JR., REPRESENTS MARLO COIL

Marlo Coil Co., St. Louis, Mo., has announced the appointment of Walter B. Moses, Jr., as regional representative in Louisiana, Mississippi, Alabama and Northwestern Florida, effective September 1, 1945.

Mr. Moses, a graduate engineer, is well known in the refrigeration and air conditioning field and a member of the ASHVE. He is resuming his commercial and engineering activities after wartime service as assistant naval architect of Pendleton Shipyards Co., Inc., at New Orleans.

His headquarters will be at 7836 St. Charles St., New Orleans.

In an earlier announcement of the appointment of Mr. Moses (October-November 1945) it was unfortunate that the "Jr." was omitted and that the address of Marlo Coil Co. was incorrectly given.

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LIFE MEMBER JOHN B. FEEHAN PASSES

Word has been received at Society Headquarters of the death of John B. Feehan, age 81, at Marblehead, Mass., on April 25, 1946.

Mr. Feehan was born April 24, 1865, at Lawrence, Mass., where he received his elementary education. He was a graduate of the International Correspondence School and began his career installing steam and hot water heating systems in Lynn, Mass., and locality. He was president and treasurer of John B. Feehan, Inc., heating and plumbing contractors. Mr. Feehan was elected to life membership in 1938 and has been affiliated with the Massachusetts Chapter of the Society for nearly 25 years.

The Officers and Council of the Society mourn his passing and extend to his family their deepest sympathy.

SUMMARY OF LOCAL CHAPTER MEETINGS*

ATLANTA—May 27. Subject: Electronics. Speaker: Gordon Volkenant, Coordinator of New Products Research, Minneapolis-Honeywell Regulator Co. Using an oversize hairpin, a hardware cloth screen, a tin can and a drinking glass, the speaker highlighted electronic development from de Forrest's discovery through the fantastic applications of World War II. A spirited discussion followed the talk. Attendance, 87. Attendance ratio, 0.45.

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CENTRAL NEW YORK— May 14. Members of the *ASRE* joined with the Central New York Chapter of the ASHVE in an outing and clam bake. A good time was reported by all who attended the meeting which was designed to *shake loose the cobwebs.* Attendance, 75.

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CENTRAL OHIO—May 20. Subject: Modular Coordination. Speaker: Frederick Heath, Jr., Owens-Corning Fiberglas Corp., Toledo, Ohio. This subject was presented in a most pleasing and interesting manner by the speaker and was accompanied by a sound film in color, *A Scotsman Looks at Modular Coordination.* A question and answer period followed the talk. Attendance, 49. Attendance ratio, 0.60.

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CINCINNATI—May 14. This was the annual meeting and outing of the chapter. Some of the golf enthusiasts collected at the Kenwood Country Club in the afternoon, after which members and guests gathered for an informal cocktail hour, followed by dinner. The meeting was devoted to chapter business and election of new officers. Attendance, 37.

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CONNECTICUT—May 19. The meeting was devoted to chapter business and J. J. Vreeland of Chase Brass & Copper Co., Waterbury, was the speaker. Attendance, 56. Attendance ratio, 0.3.

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GOLDEN GATE—May 16. Subject: Steel Heating Boilers. Speaker: J. M. Hartman, research engineer in charge of laboratories, Kewanee Boiler Co. An open discussion followed this comprehensive talk on the history and development of the steel heating boiler. Attendance, 51. Attendance ratio, 0.57.

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INDIANA—June 7. Subject: All-Year Gas Air Conditioning Unit and Its Application. Speaker: H. C. Pierce, asst. manager, Air Conditioning Div., Servel, Inc., Evansville. Attendance, 52.

INDIANA—May 3. After the election of officers and other chapter business, James H. Obear, sales manager, Enos Coal Mining Co., presented the following films: *Production of Tailor-Made Coal, A Brief Study of Fuel Beds* and *The Effect of Over-Fire Air.* Attendance 45. Attendance ratio, 0.54.

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KANSAS CITY—May 6. Subject: Pre-Sealed Conduit. Speaker: George P. O'Connor, general sales manager, Ric-WiL Co. The speaker gave a very interesting talk illustrated with slides. Gerald Coel, senior training officer, Veterans Administration, explained the service of the vocational training program. J. P. Turner, General Electric Co., showed a film covering the preservation of food by freezing. Attendance, 53.

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MASSACHUSETTS—May 9. Subject: The Value of Air Conditioning in Precision Manufacturing. Speaker: E. D. Tutt, chief engineer, Tuttle & Bailey, Inc., New Britain, Conn. This was a joint meeting of ASHVE and *ASRE*. Charles S. Leopold, national president of *ASRE* was in attendance and conducted an interesting discussion period. Attendance, 25. Attendance ratio, 0.333.

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MEMPHIS—June 3. The entire time was devoted to election of officers and other chapter business. Attendance, 21. Attendance ratio, 0.656.

MEMPHIS—May 6. Subject: Duties of an Industrial Hygiene Engineer. Speaker: Francis P. Jung, industrial hygiene engineer, State Department of Health, Tennessee. Attendance, 16. Attendance ratio, 0.50.

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MICHIGAN—May 28. The annual meeting of the chapter was held at the Meadowbrook Country Club where the fine weather encouraged 36 golfers. At the meeting committee reports were given and the new officers installed. Attendance, 66. Attendance ratio, 0.4

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MINNESOTA—May 6. Subject: The Society Research Program. Speaker: Cyril Tasker, director of research, ASHVE. Mr. Tasker's talk was illustrated by slides showing an outline of the work being done at various universities and at the Laboratory, as well as several photographs of the newly acquired Laboratory building in Cleveland. Prof. F. B. Rowley outlined the history of the Society's research program and introduced C. A. McKeeman, assistant to the president of the Society, a guest at the meeting.

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MONTREAL—April 15. Subject: Housing and Labor Relations — Apprenticeship Training in Industry

*Note. The attendance ratios shown represent the membership attendance divided by the chapter membership. These ratios will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

eaker: J. L. E. Price. This subject invited many ding comments and queries from the members. At- ndance, 36.

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NEW YORK—May 20. Subject: Engineering the Heat- g of Veterans' Homes—An Opportunity for the SHVE and Its Members. Speaker: Robert K. Thul- an, chief engineer, F. H. A., Washington, D. C. Mr. hulman explained the steps being taken to provide ouses for veterans and also described features of eating and plumbing systems seen during his recent sit to England. A question period followed the presen- tion. The chapter presented to the Society $634.70 to lp reduce the mortgage on the new Research Labora- ry building. Attendance, 95. Attendance ratio, 0.57.

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NORTH TEXAS—May 22. Subject: Necessity of Con- rving Natural Gas. Speaker: L. S. Reagan, president, ebster Engineering Co. Tulsa, Okla. The speaker in- ded in his talk descriptions of new combustion con- ol, flame-actuated pilot valves, proper sizing of burn- s, draft problems, insurance company requirements d boiler ratings. A period of open discussion followed. ttendance, 89. Attendance ratio, 1.78.

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NORTHERN OHIO—May 13. Subject: When Is Air Con- tioning of a Modern Factory Advisable. Speaker: H. Mosher, Eastman Kodak Co. Mr. Mosher gave a ry commendable talk and a long question and dis- ssion period was enjoyed. Attendance, 88. Attend- ce ratio, 0.57.

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PACIFIC NORTHWEST—May 17. Subject: Reverse Cycle Its Practicability in the Pacific Northwest. Speaker: hard M. Stern, *ASRE*. The talk dealt generally with subject of reverse use of refrigerating equipment heating on air conditioning systems, with analysis possible installation of various sizes for four repre- tative cities—Seattle, Portland, Spokane and Boise. of. E. O. Eastwood, University of Washington, and st president of the ASHVE, led the discussion follow- the talk. This was the yearly joint meeting of the *RE* and the ASHVE. Attendance, 27.

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PHILADELPHIA—May 14. The annual outing was held the Llanerch Country Club. A resolution was pre- ted at the meeting on the passing of Wilbur Smith d sent to his family. Attendance, 82.

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PITTSBURGH—May 13. The entire evening was spent chapter business and entertainment. It was voted d carried that $200 be presented to the Society to p reduce the mortgage on the new Laboratory build- in Cleveland. Attendance, 43. Attendance ratio, 0.49.

ROCKY MOUNTAIN—Subject: The Society's Research Activities. Speaker: Cyril Tasker, director of research, ASHVE. Mr. Tasker presented a highly interesting and informative outline illustrated with slides of the Society's past research activities, present considerations and future possibilities. A question period followed. Attendance, 34. Attendance ratio, 0.33.

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SOUTH TEXAS—May 17. Subject: Evaluation of Kool-Shade Blinds. Speaker: A. Ford Lovelace. Much of the time was spent on regular chapter activities, installation of new officers and committee reports. Attendance, 69.

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SOUTHERN CALIFORNIA—June 12. Subject: Self-Contained Air Conditioning Units for Year-Round Conditioning. Speaker: Art Michael, Southern California Gas Co. Following the showing of slides, the discussion was thrown open for a question and answer period. Attendance, 70.

SOUTHERN CALIFORNIA—May 8. Subject: Various Aspects of Air Pollution Control. Speaker: F. A. Deutch, air pollution engineer, Office of Air Pollution Control, County of Los Angeles. C. G. Beer spoke on weather and pressure conditions in the Los Angeles area, pointing out the effects they have on the smoke abatement problem. After the talks a question and answer period followed. Attendance, 47.

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WASHINGTON, D. C.— May 8. Subject. Dehumidification for Preservation of the U. S. Fleet. Speaker: Capt. T. H. Urdahl, vice chairman, Executive Committee on Research. The talk was illustrated by a moving picture. Attendance, 64. Attendance ratio, 0.53.

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WESTERN MICHIGAN—April 8. Subject: Heating by Radiant Energy. Speaker: Irving E. Brooke, Chicago. Attendance, 84. Attendance ratio, 1.31.

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WESTERN NEW YORK—May 13. Regular chapter business was taken care of and new officers installed. Two short movies in color were then shown describing the use and application of electronic tubes. Attendance, 21.

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WISCONSIN—May 14. Subject: The Post War Era—A Challenge to Heating and Air Conditioning Engineers. Speaker: Pres. Alfred J. Offner. This meeting was a 3 *star event*, featuring the National President, the Annual Meeting and the Ladies. Annual reports were given by officers and committees and the new officers were installed. Attendance, 67. Attendance ratio, 0.71.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month, 58 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by August 10, 1946, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

ALLSHOUSE, IRVIN P., Cons. Engr., B. F. Sturtevant Co. PROPOSERS: C. M. Burnam, Jr., R. S. Moore. SECONDERS: A. H. Goelz, W. F. Christmann.

AMEZAGA, M. F., Vice-Pres., Compania Electric de Cuba. PROPOSERS: H. H. Koster, J. W. Booker. SECONDERS: E. del Campo, Charles Andreas.

AUSLANDER, GEORGE, Pres., Public Service Heat & Power Co. PROPOSERS: A. J. Offner, W. E. Ritz. SECONDERS: L. E. Eden, G. C. Beck.

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BLUM, R. D., Sr. Applica. Engr., York Corp. PROPOSERS: E. R. Walsh, Jr., S. F. Nicoll. SECONDERS: V. T. Kartorie, L. S. Morse, Sr.*

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BRUCE, MARSHALL, Secy.-Treas., George W. Akers Co. PROPOSERS: G. W. Akers, E. F. Hyde. SECONDERS: W. H. Old, A. E. Knibb. (*Advancement*)

BUCKLEY, N. A., Grad. Student, University of Illinois, Urbana, Ill. PROPOSERS: S. Konzo, A. P. Kratz. SECONDERS: J. R. Fellows, J. A. Henry.*

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★ **CLEVELAND, OHIO** ★

53rd Annual Meeting

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

to be held

★ January 27-31, 1947

7th International

HEATING AND VENTILATING EXPOSITION

to be held

January 27-31, 1947, Lakeside Hall ★

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CANDIDATES ELECTED

In the past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

Members

BODINUS, W. S., Branch Mgr., Carrier Corp., Chicago, Ill.
CLARKE, J. L., Owner, Clarke Bros., Indianapolis, Ind.
COX, WILLIAM A., Jr., Pres., Cox-Frank Corp., Norfolk, Va.
CRAWFORD, J. N., Sales Mgr., Bryant Heater Co., Cleveland, Ohio.
EVANS, D. A., Engr., National Tube Co., Pittsburgh, Pa.
FRANKHOUSER, E. V., Supt. of Power, Radio Corporation of America, Camden, N. J.
GARDNER, C. R., Vice-Pres., Martyn Brothers, Inc., Dallas, Tex.
GRAGG, H. G., Sales Engr., Air Filter & Equipment Co., Chicago, Ill. *(Advancement)*
HANSON, F. E., Gas Engr., Servel, Inc., Evansville, Ind.
HARRIS, H. Melvin, Engr., Baltimore, Md. *(Reinstatement)*
HOPPIN, C. A., Sr., Mgr., Sales & Service, Laclede Gas Light Co., St. Louis, Mo.
JENKINS, R. L., Cons. Mech. Engr., Houston, Tex.
JOHNSON, R. L., Asst., Head, Research Dept., Young Radiator Co., Racine, Wis. *(Advancement)*
JOUANNO, E. P., Gen. Mgr., Societe Autocalor, Paris, France.
KELLY, L. R., Cons. Engr., Los Angeles, Calif.
LUBINSKY, R. G., Mgr., The Trane Co., LaCrosse, Wis.
LUCEY, R. E., Mgr., Products Engr. Dept., The Trane Co., La Crosse, Wis.
MOORE, J. J., Engr., A. M. Byers Co., Pittsburgh, Pa.
MUNN, H. F., Vice-Pres., Albuquerque Lumber Co., Albuquerque, N. M.
PENDLETON, M. E., Dist. Mgr., Armstrong Cork Co., Buffalo, N. Y.

REPINO, P. A., Plant Engr., Lebanon Steel Foundry, Lebanon, Pa. (*Advancement*)
RINGQUIST, C. L., Air Cond. Dept. Mgr., The Trane Co., La Crosse, Wis.
WILL, H. C., Mgr., Air Cond. Div., J. A. Walsh & Co., Houston, Tex.
WALKER, W. S., Asst. Control Dir., Consolidated Edison Co. of New York, Inc., New York, N. Y.
WELTER, GUSTAVE, Vice-Pres., The Bigelow Co., New Haven, Conn.
WHITE, J. A., Engr., Iron Fireman Manufacturing Co. of Canada, Ltd., Toronto, Ont., Canada.
WHITE, J. E., Mech. Engr., Norfolk Naval Shipyard, Portsmouth, Va.
WOOD, F. C., Mgr., Air Cond. Dept., York Corp., York, Pa. (*Advancement*)
WOODSON, J. W., Owner, Woodson Heating Co., Detroit, Mich. (*Advancement*)

Associate Members

ALLEN, C. G., Engr., Bryant Heater Co., Cleveland, Ohio.
ALLEN, W. W., Jr., Branch Mgr., Owens-Corning Fiberglas Corp., Minneapolis, Minn.
ALLISON, H. H., Specification Engr., United Rexall Drug Co., Los Angeles, Calif.
BERGMAN, HAROLD, Sales Repr., J. A. Zurn Manufacturing Co., Cleveland, Ohio.
BLANKENSHIP, DICK, Engr's. Asst., W. Bruce Morrison, Portland, Ore.
BONEBRAKE, J. H., Asst. to J. Donald Kroeker, Portland, Ore.
BROOKE, J. O., Owner, The Brooke Co., Davenport, Ia.
BROWN, D. A., Vice-Pres., Texas Engineering Co., Inc., Houston, Tex.
BUTLER, D. H., Sales Mgr., Iron Fireman Manufacturing Co., Toronto, Ont., Canada.
CAPPS, EDGAR L., Comm'l. Sales Mgr., R. F. Trant, Inc., Norfolk, Va. (*Reinstatement*)
CARLSON, E. E., Engr., B. F. Sturtevant Co., Boston, Mass.
CHAMPAGNE, ALEX, Owner, Champagne & Sons, Montreal, Que., Canada.
DANIELSON, Lloyd C., Chief Engr., J. A. Jones Construction Co., Oak Ridge, Tenn. (*Reinstatement*)
DAWSON, R. E., Chief Engr., Green Colonial Furnace Co., Des Moines, Ia.
DIXON, M. F., Combustion Engr., Imperial Oil, Ltd., Toronto, Ont., Canada. (*Reinstatement*)
DOUDICAN, C. T., Htg. Engr., M. J. Gibbons Supply Co., Dayton, Ohio.
DOUGHERTY, C. P., Owner, Dougherty Heating Co., Portland, Ore.
ELLIS, M. H., Jr., Sales Engr., Armstrong Cork Co., Memphis, Tenn.
FELZER, WILLIAM, Naval Archt., U. S. Navy Depart., San Francisco, Calif.
FICARRA, F. X., Designer, Meyer, Strong & Jones, Inc., New York, N. Y.
FISHER, S. L. V., Air Cond. Engr., Trane Co. of Canada, Ltd., Toronto, Ont., Canada.
GERHARDT, E. D., The Glenn L. Martin Co., Baltimore, Md.
GOWAN, G. J., Engr., East Ohio Gas Co., Cleveland, Ohio.
GRAY, R. O., Htg. Engr., H. F. Brown, Norfolk, Va.
GUY, J. A., Htg. & Plbg. Engr., Sauer Co., Inc., Columbus, Ohio.
HAINES, R. W., Engr., The King Co., Owatonna, Minn.
HEAD, F. T., Mgr., Space Htg. Div., Consolidated Edison Co. of New York, Inc., New York, N. Y.
HEALY, D. L., Jr., Sales Engr., Healy-Ruff Co., St. Paul, Minn.
HULL, J. J., Asst. Service Mgr., The Bridgeport Gas Light Co., Bridgeport, Conn.
JACKSON, R. O., Sales Engr., Jackson Engineering Co., Indianapolis, Ind.
JONES, C. D., Mgr., Charles D. Jones & Co., Kansas City, Mo.
KAPLAN, M. J., Htg. Engr., Veterans Administration Construction Service, New York, N. Y.
KELLY, E. L., Mech.-Elec'l. Engr., Federal Public Housing Authority, San Francisco, Calif.
KENDRICK, A. E., Dist. Mgr., Pacific Coast Heating & Appliance Co., Portland, Ore.
KIRKWOOD, T. A., Sales Engr., American Radiator & Standard Sanitary Corp., Charlotte, N. C.
KLINE, FRANCIS L., Gas Engr., Iowa Power & Light Co., Des Moines, Iowa.
KRAUSE, L. J., Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
LAMBERSON, L. D., Jr., Engr., Williamson Favret Furnace Co., Columbus, Ohio.
LAMBERT, Ernest, Warden King, Ltd., Toronto, Ont., Canada.
LEMKAU, HERBERT, Product Applica. Engr., Crane Co., San Francisco, Calif.
LUNDBERG, O. A., Htg. Contractor, Los Angeles, Calif.
MACNAMARA, ROGER, Sales Repr., Orlando, Fla.
MANDELL, LEONARD, Engr., Providence, R. I.
MARTEL, CHARLES L., Cons. Engr., Martel Engineering Co., Inc., Detroit, Mich. (*Reinstatement*)
MILLER, ORVILLE, JR., Sales Engr., Owens-Corning Fiberglas Corp., Chicago, Ill.
MOODY, W. D., Vice-Pres., Barber Plumbing Co., Inc., Houston, Tex.
ORAVETZ, J. A., Sheet Metal & Htg. Foreman, War Department Engineers, Fort Sheridan, Ill.
OWENS, D. F., Engr., Neil H. Peterson Co., San Francisco, Calif.
PANAR, DAVID, Engr., Air Vent. Sheet Metal, Montreal, Que., Canada.
POTTER, R. E., Mech. Engr., The Austin Co., Jersey City, N. J.
PRITCHARD, H. T., Gen. Mgr., Robert T. Purves, Ltd., Toronto, Ont., Canada.
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SCOTT, ANGUS C., Engr., Hall-Neal Furnace Co., Indianapolis, Ind. (*Reinstatement*)
SCURLOCK, U. M., Owner, Bill Scurlock Air Conditioning & Heating Service Co., Kansas City, Mo.
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STERN, R. M., Mech. Engr., McClelland & Jones and Associates, Seattle, Wash.
TAPPEN, M. M., Sales Engr., Johnson Service Co., Des Moines, Ia.
TAYLOR, M. I., Mfr's. Agent, Bell & Gossett Co., Richmond, Va.
THOMAS, F. A., Maintenance Engr., Bathurst Power & Paper Co., Bathurst, N. B., Canada.
WEENINK, C. A., John Weenink & Sons Co., Cleveland, Ohio.
WIEGMANN, K. H., Plant Engr., Durite Plastics, Inc., Philadelphia, Pa.
WIIK, A. O., Mgr. & Partner, Wein City Plumbing & Heating Co., Minneapolis, Minn.
WOOD, D. J., Mgr., York Corp., Cincinnati, Ohio.
WOOD, G. K., Sales Engr., Ilg Electric Ventilating Co., Columbus, Ohio.

Junior Members

ALLEN, R. F., Engr., Carrier Corp., Syracuse, N. Y.
ALLINGHAM, J. F., Student, University of Toronto, Toronto, Ont., Canada.
ANDERSON, E. R., Applica. Engr., B. F. Sturetvant Co., Indianapolis, Ind.
COCHRANE, R. L., Jr., Htg. Engr., The James Robertson Co., Ltd., Toronto, Ont., Canada.
FAKTER, MELVIN, Engr., The Austin Co., 510 N. Dearborn St., Chicago, Ill.
HOOPER, F. C., Student, University of Toronto, Toronto, Ont., Canada.
JAHN, W. E., Instructor, University of Minnesota, Minneapolis, Minn.
MOLLOY, E. J., Jr., Student, University of California, Berkeley, Calif.
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SCHMIDT, J. F., Student Engr., Carrier Corp., Syracuse, N. Y.
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WILDER, F. B., Student, Massachusetts Institute of Technology, Cambridge, Mass.
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WRENE, N. T., Engr., Passaic, N. J.

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Delta: Organized, 1939. Headquarters, New Orleans, La. Meets, Second Tuesday. President, W. P. Oster, 410 Camp St., New Orleans 12. Secretary, F. G. Burns, 317 Baronne St., New Orleans, 9.

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Kansas City: Organized, 1917. Headquarters, Kansas City, Mo. Meets, First Monday. President, S. L. Furber, 7429 Forest Ave., Kansas City 5. Secretary, H. E. Gould, 1800 Baltimore, Kansas City 8.

Manitoba: Organized, 1935. Headquarters, Winnipeg, Man., Canada. Meets, Third Thursday. President, F. T. Ball, 324 Main St., Winnipeg. Secretary, D. S. Swain, 1186 Downing St., Winnipeg.

Massachusetts: Organized, 1912. Headquarters, Boston, Mass. Meets, Third Tuesday. President, D. M. Archer, 143 Federal St., Boston 10. Secretary, A. Ehrenzeller, 23 Parklawn Rd., Boston 32.

Memphis: Organized, 1944. Headquarters, Memphis, Tenn. Meets, First Monday. President, T. J. O'Brien, 1030 Exchange Bldg., Memphis. Secretary, A. T. Bevil, 1521 Waverly Ave., Memphis 6.

Michigan: Organized, 1916. Headquarters, Detroit, Mich. Meets, First Monday after 10th of month. President, F. R. Bishop, 8011 Dexter Blvd., Detroit 6. Secretary, L. A. Burch, 78 Amherst Rd., Pleasant Ridge, Royal Oak.

Minnesota: Organized, 1918. Headquarters, Minneapolis, Minn. Meets, First Monday. President, J. E. Haines, 2747 Fourth Ave., S., Minneapolis 8. Secretary, O. L. Lilja, 5000 16th Ave., S., Minneapolis 7.

Montreal: Organized, 1936. Headquarters, Montreal, Que., Canada. Meets, Third Monday. President, A. B. Madden, 1176 Beaver Hall Sq., Montreal, Que. Secretary, S. W. Salter, 910 New Birks Bldg., Montreal.

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North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. Acting President, W. H. Sullivan, Jr., 3124 S. Green St., Greensboro. Secretary, M. D. Brown, 602 Reynolds Bldg., Winston-Salem.

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, E. J. Stern, 701 Burt Bldg., Dallas 1. Secretary, B. S. Foss, Jr., 3517 Oak Lawn Ave., Dallas 4.

Northern Ohio: Organized, 1916. Headquarters, Cleveland, Ohio. Meets, Second Monday. President, J. E. Wilhelm, 1366 Euclid Ave., Cleveland 15. Secretary, D. E. Mannen, Jr., 4517 Silsby Rd., University Heights.

Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, G. T. Donceel, Oklahoma Natural Gas Co., Oklahoma City. Secretary, W. W. Frankfurt, 519 Apco Tower, Oklahoma City.

Ontario: Organized, 1922. Headquarters, Toronto, Ont., Canada. Meets, First Monday. President, V. J. Jenkinson, 117 Peter St., Toronto 2B. Secretary, H. R. Roth, 57 Bloor St., W., Toronto, Ont.

Oregon: Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, F. F. Urban, 6725 S. W. Burlingame Ave., Portland. Secretary, E. R. Lokey, 1250 N. W. Glisan St., Portland 9.

Pacific Northwest: Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, R. E. Le Riche, 6345 39th S. W., Seattle 6. Secretary, C. W. Finn, 702 Lloyd Bldg., Seattle 1.

Philadelphia: Organized, 1916. Headquarters, Philadelphia, Pa. Meets, Second Thursday. President, R. D. Touton, Ninth & Columbia Ave., Philadelphia. Secretary, F. H. Buzzard, 213 S. Broad St., Philadelphia 7.

Pittsburgh: Organized, 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, A. F. Nass, 527 First Ave., Pittsburgh 19. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

Rocky Mountain: Organized, 1944. Headquarters, Denver, Colo. Meets, First Wednesday. President, F. L. Adams, P. O. Box 849, Denver 1. Secretary, J. J. Johnson, 1010 17th St., Denver 2.

St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, B. C. Simons, 4030 Chateau, St. Louis 10. Secretary, W. A. Russell, 7918 Kingsbury Blvd., Clayton 5, Mo.

South Texas: Organized, 1938. Headquarters, Houston, Tex. Meets, Third Friday. President, B. P. Fisher, P. O. Box 92, Houston 1. Secretary, C. C. Quin, 809 Stuart Ave., Houston 6.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Second Wednesday. President, Art Theobald, 116½ S. Kings Rd. Secretary, R. S. Farr, 2615 Southwest Dr., Los Angeles 43.

Utah: Organized, 1944. Headquarters, Salt Lake City, Utah. Meets, First Wednesday. President, J. T. Young, Jr., Box 709, Ogden. Secretary, E. J. Watts, 2485 Douglas St., Salt Lake City 5.

Virginia: Organized, 1946. Headquarters, Norfolk, Va. President, R. C. Thomas, 819 Westover Ave., Norfolk 7. Secretary, J. F. Reynolds, Gatling and Marole Ave., Norfolk 2.

Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, L. B. Nye, Jr., 1100 11 St., N. W., Washington. Secretary, J. N. Stewart, 6124 32nd Pl., N. W., Washington 15.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, J. W. Miller, Route 5, Box 498, Lansing. Secretary, K. E. Robinson, 211 Smith Ave., Lansing 10.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, Herman Seelbach, Jr., 45 Allen St., Buffalo 2. Secretary, F. J. Weber, 443 Delaware Ave., Buffalo 4.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, E. W. Gifford, 611 N. Broadway, Milwaukee 2. Secretary, B. M. Kluge, 1817 S. 66th St., Milwaukee 14.

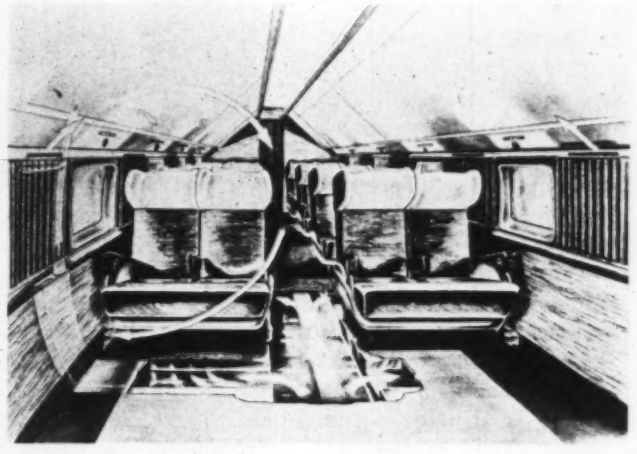
EQUIPMENT DEVELOPMENTS

For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January 1946 Heating, Piping & Air Conditioning and thus keep your records of sources of supply up to date throughout the year. Single asterisk indicates equipment not listed in Directory Section; double asterisk equipment and manufacturer not listed.

Aircraft Heater for Radiant Heating, Ventilating, and De-Icing Systems

No. 3166—Surface Combustion Corp., 2375 Dorr St., Toledo 1, Ohio, has announced new uses for the company's line of "Janitrol" aircraft heaters in connection with complete, year-around air conditioning of airplane cabins and for de-icing systems.

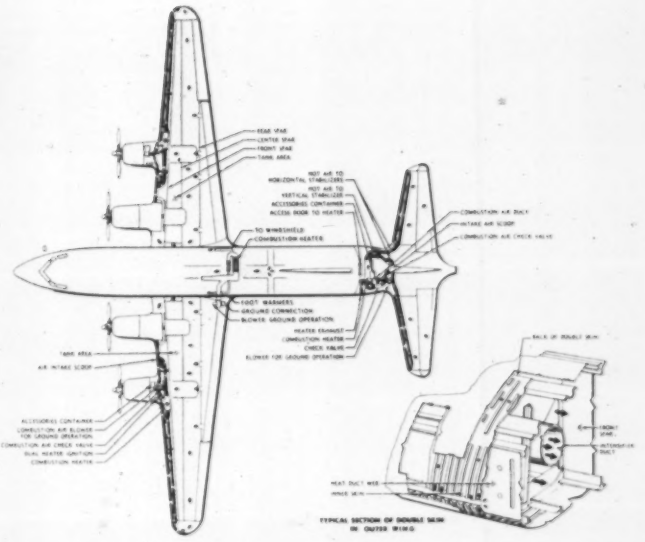
According to the heater manufacturer, the new Douglas DC-6 airliner, now coming off the production lines, has a cooling system for warm weather and a combination radiant heating and ventilating system



for cold weather. As shown in the above illustration, a supply duct running the length of the cabin under the center aisle carries fresh air and heat from the combustion heater, which are blended at a maximum temperature of 85 F. Branch ducts carry the warm air to side panels at every seating section. The cabin floor plates form the top of the ducts and thus provide warm panel sections. The branch ducts carry the heat to panels between the outer skin and the cabin and, for ventilation, the tempered air is discharged from the side panels at a point just below the hat racks in the cabin. The air leaves the cabin through grilled openings in the side walls near the floor of each outside seat. Cooled air is distributed through the same system in warm weather, and on sleeper planes, a special duct system is used to discharge overboard the spent air from each upper and lower berth.

The aircraft heater operates only when air from the supercharger is at a temperature insufficient to heat the cabin. The same heater also supplies heat for de-icing the windshield and for the cockpit, and a damper system and automatic controls provide means for recirculating 50 per cent of the cabin air.

A new feature on this plane is the use of three similar heaters, one located in each wing and one in the



rear of the fuselage, for de-icing. They are designed for either ram air operation or in conjunction with the cabin superchargers. A duct carries hot air from the combustion heater along each wing with air entering a plenum at several points. This plenum is formed by a vertical web. Hot air is forced out through a horizontal slot in the inner skin, against the inside of the outer surface being anti-iced. After serving its purpose, the air is exhausted through ports in the wing surface. Empennage ice prevention is accomplished in a similar manner.

Grease Filter

No. 3167—A new grease filter designed specifically to combat fires in restaurants and taverns has been developed by Research Products Corp., 1015 E. Washington St., Madison 3, Wis.

The filter is an all metal washable type. Sheets of aluminum alloy foil are cut with a series of slits and are then expanded. Twenty layers of the foil are cut with a progressively larger pattern and are placed together to form a honeycomb design which is said to be 98 per cent efficient in removing entrained grease from ventilation exhaust systems of kitchens, galleys, etc.

Heating, Piping & Air Conditioning, [7-46]
6 N. Michigan Ave., Chicago 2, Ill.

Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in Equipment Developments and Recent Trade Literature.

(Circle each number in which you are interested)

3166	3167	3168	3169	3170	3171	3172	3173	3174	3175
3176	3177	3178	3179	3180	3181	3182	3183	3184	3185
3186	3187	3188	3189	3190	3191	3192	3193	3194	3195
3196	3197	3198	3199	3200	3201				
6204	6205	6206	6207	6208	6209	6210	6211	6212	6213
6214	6215	6216	6217	6218	6219	6220	6221	6222	6223
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No friction loss to affect accuracy... no stuffing box leaks

COUNTERBALANCED PEN
Always remains in proper adjustment

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LARGE ILLUMINATED FLOW INDICATOR

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Totalizing the flow

Takes Sudden Overloads or Reverse Flows Without Damage

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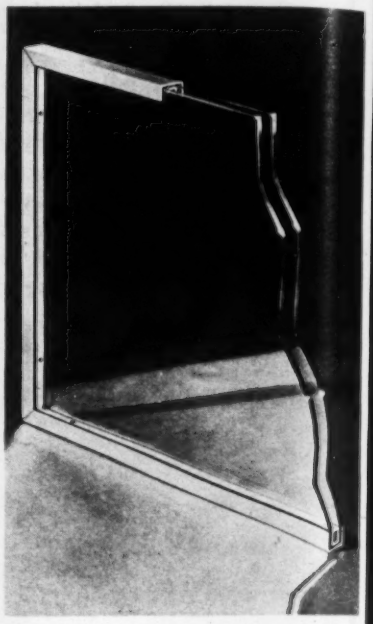
MAKERS OF UP-TO-DATE STEAM LINE EQUIPMENT FOR OVER 65 YEARS

New Type Double Glazed Window

No. 3168—Development of a new type, double-glazed window insulating unit known as "Twindow" has been announced by the Pittsburgh Plate Glass Co., 632 Duquesne Way, Pittsburgh 22, Pa.

These integral insulating units of two or more plates of glass enclosing a ¼ in. or ½ in. hermetically sealed air space feature the use of hollow aluminum tubing to separate and hold the glass plates in position. The entire unit is framed with a light-gauge stainless steel channel with the channel legs extending ⅜ in. inward on the surface of the glass from the base around its periphery to give protection during installation and use.



The units are said to constitute one of the most efficient thermal and dust insulation units yet developed and to virtually prevent condensation.

The air in the space between the plates of glass is held at atmospheric pressure and is dehydrated initially by means of a drying agent within the aluminum spacer tubing which has access to the air space through holes adjacent to the internal corners. This is said to provide a hermetically perfect seal. The drying agent or desiccant remains in the unit and provides added insurance against vapor diffusion and helps considerably in meeting more than normal atmospheric changes. Clear polished plate glass is used in construction of the standard unit. In addition, however, units can be fabricated with special glasses to meet practically all needs.

Specially developed production processes make it possible to provide units in a wide range of sizes in any combination of straight edges. These units include the standard double glazing as well as the special triple, quadruple, and multiple glazed panels. It is also possible to produce certain simple cylindrical bends within definite limitations.

Low Side Cooling Unit

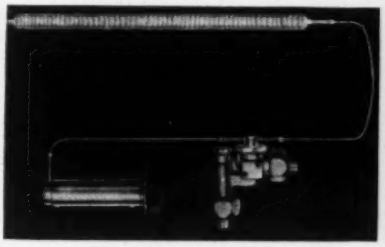
No. 3169—A new vertical, low side cooling unit has been added to the line of "Typhoon" self-contained air conditioning units manufactured by the Ice-Air Conditioning Co., 794-6 Union St., Brooklyn 15, N. Y.

Made with two coil sizes and two sizes of fan motors (3 and 5 ton), the unit is designed for use as a central plant or in a unit system with any type compressor-condenser unit. The insulated cabinet is 35 in. wide, 40 in. deep, and 57 in. high. The removable front panel permits accessibility to the filters, expansion valve, coil, motor, and blower.

Hot Water Flow Control Valve

No. 3170—The No. 522 regulator has been designed by The Fulton Sylphon Co., Box 400, Knoxville 4, Tenn., to control hot water flow to individual concealed type radiators or convectors or to hot water reheaters for heating and ventilating systems.

Furnished with union ends for ½ in. standard pipe, the unit may be used for any 20 deg temperature range between 40 and 120 F. The normal temperature differential for the full valve travel is 3 deg and the maximum pressure drop across the valve is 10 psi. The unit is designed for 80 psi maximum static water pressure.



It is furnished with a monel wire strainer at the inlet connection, a bakelite adjustment knob, steel unions, and other parts of brass or copper.

Small Steam Trap

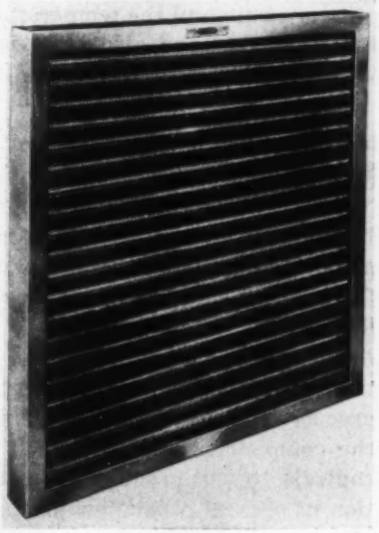
No. 3171—Sarco Co., Inc., 475 Fifth Ave., New York 17, N. Y., has announced the addition of a small thermostatic steam trap (No. 10) to the company's line of steam specialties.

Developed for use on instrument sterilizers, water stills, plate warmers, and other small steam heated equipment, the unit can also be used as a compact, high pressure thermostatic air vent. It is equipped with a helically corrugated bronze bellows, a brass body, and a renewable valve head and seat of stainless steel. Maximum operating pressure is 100 psi and dimensions are 2⅝ in. high and 1 in. center to face of inlet. The weight is 13 oz and connection sizes are ¼ or ⅜ in. ips.

Activated Carbon Odor Adsorption Panels

No. 3172—"Dorex" type G activated carbon, odor adsorption panels have been developed by W. B. Connor Engineering Corp., 114 E. 32nd St., New York 16, N. Y., for use in air conditioning systems and package conditioners where space is at a premium.

One of the many uses for these panels is in the air conditioning systems of railroad cars. Heretofore, says the manufacturer, power, weight and space limitations for cooling, heating and circulating apparatus have restricted the air design for the average railroad car, with an occupancy up to 80 passengers, to between 2000 and 2400 cfm total air delivery, out of which only 25 per cent is outdoor makeup. The remaining 75 per



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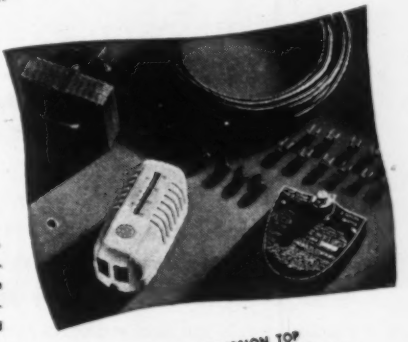
Install A-P THERMOSTATIC HEAT CONTROL on all your present Oil Burning Space Heaters!

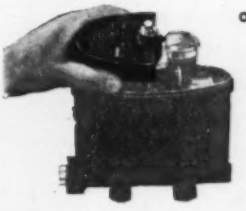
This new "Sales Package" can be installed on *any* oil burning space heater using any A-P Constant Level Oil Control made since 1938. This means *extra* sales to most of the customers to whom you sold heaters since 1939, for they will all welcome the added convenience, luxury and oil-saving advantages of *Automatic Temperature Control* — steady room comfort at the touch of a thermostat dial.



A-P Model 240-ED Electric Heat Regulator Conversion Set

EASY TO INSTALL . . .

Complete Conversion Set includes: Electric Conversion Top, Wall Thermostat, Transformer, Wire, Staples and full instructions.



JUST MOUNT ELECTRIC CONVERSION TOP ON THE MANUAL CONTROL NOW ON THE HEATER . . .

CONNECT TO TRANSFORMER . . .

AND WALL-MOUNTED THERMOSTAT . . .

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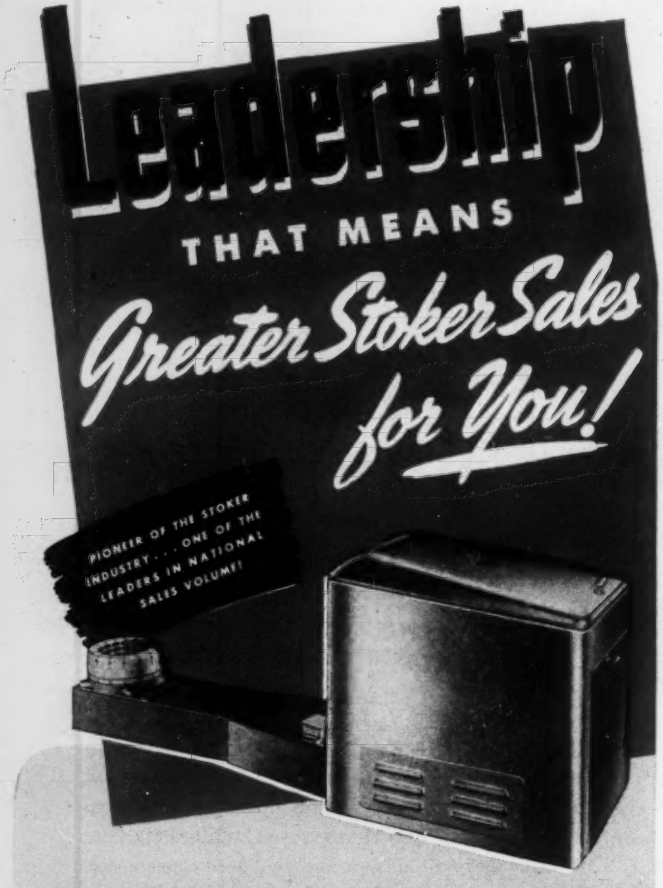
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cent is constantly recirculated and when a car is full, this air picks up and accumulates odors from smoke, food, and drink—even from passengers themselves.

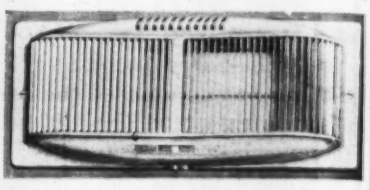
In the usual railroad car installation of these panels one half of the recirculated air is converted to "fresh" air, which, when added to the outdoor air, means that each passenger receives 23 cfm of "fresh" ventilation air instead of 9 cfm, and odors are said to be held below the point of human perception.

Panel units consist of lightweight metal frames housing a battery of perforated tubes containing specially treated activated carbon.

Self-Contained Register Grille

No. 3173*—Development of a self-contained, automatic register grille known as the "Grad-U-Flow" register for warm air systems has been announced by the Minneapolis-Honeywell Regulator Co., 2604 4th Ave., S., Minneapolis 8, Minn.

The device requires no electrical or mechanical power other than that which it generates itself through temperature changes and it is no larger than the conventional warm air outlet.



Although the selling price has not been established, it is expected that the new grille will cost little more than previous means of warm air distribution and, according to the manufacturer, will offer the advantage of individual room temperature control.

The unit consists primarily of a remote temperature bulb, a bellows, and a lever which positions the dampers to maintain the required temperature. In operation the bulb, which is mounted under a cover on the front of the grille, reacts to changes in temperature of the induced air from the room and causes the bellows to either expand or contract. A system of levers attached to the bellows opens or closes the dampers in direct response to room temperatures. The control setting is actually a screw mechanism which alters the balance point of the levers.

The outward appearance of the grille is similar to the air register which the company announced last year, the only difference being the cover for the temperature bulb and the temperature selector. The grille face is curved and also comes equipped with turning vanes.

Manufacturer of Heating Specialties Expands

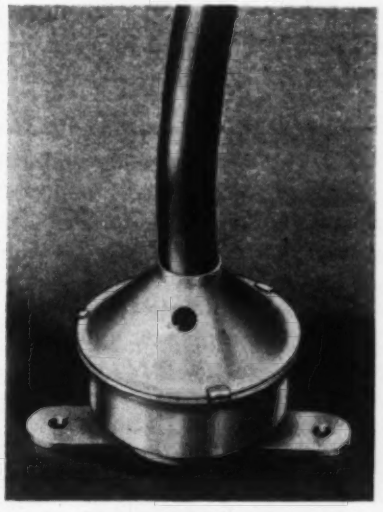
No. 3174—The Hoffman Specialty Co., 1001 York St., Indianapolis 7, Ind., is embarking on a program of expansion in anticipation of an unprecedented demand for heating equipment and accessories over the next five years.

This was disclosed by Paul G. Hoffman, chairman of the board, following a general meeting of company executives in Chicago. As a first step in this program the company recently added a broad line of heating controls to the products it distributes and the addition of several other new products is planned.

Hermetically Sealed Snap Action Thermostat

No. 3175—The Spencer Thermostat Co., 34 Forest St., Attleboro, Mass., has announced a new hermetically sealed snap action thermostat, "C-4910," for temperature regulation or high limit alarms in refrigeration or other cooling or heating applications.

These fixed temperature, nonadjustable thermostats are for use in such applications as frozen food cabinets, bottle dispensers, refrigerated show cases, and walk-in coolers, as well as in heating applications requiring a hermetically sealed snap action thermostat.



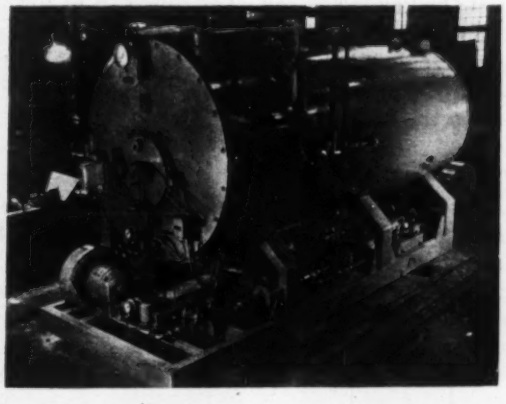
They are actuated by the company's snap acting disc mounted in thermal contact with the sealed housing, and are said to operate in any position and are unaffected by ordinary vibration.

Minimum temperature setting is –10 F; maximum standard temperature setting 120 F. Minimum cooling temperature differential, with contacts closing on temperature rise, is 8 F. Minimum heating temperature differential, with contacts opening on temperature rise, is 10 F. Higher settings and wider differentials can be specified. They are available in the following electrical ratings for a-c or d-c application: 115-230 volts a-c, 10 amp, ½ hp; 125 volts d-c, 1 amp.

Steam Generator for Oil or Gas Firing

No. 3176—The "Amesteam" generator, manufactured by Ames Iron Works, Division of Pierce Butler Radiator Corp., Oswego, N. Y., has been completely redesigned and improved.

The present unit is the outgrowth of considerable experience during the war, when the company manufactured nearly 3000 steam generators for the armed forces. It is now available for operation with liquid fuel ranging from gasoline to No. 6 oil, and with either natural or manufactured gas. Standard sizes are from 10 to 300 hp with pressures from 15 to 200 psi.



EASY-FLO brazing-

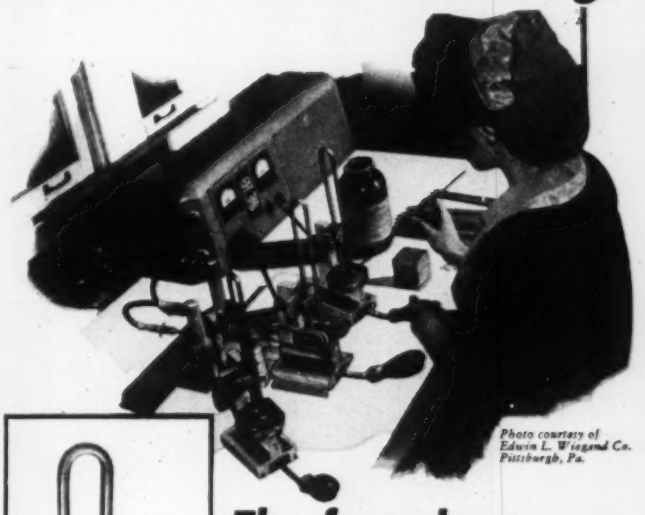


Photo courtesy of Edwin L. Wiegand Co. Pittsburgh, Pa.

At right, above, you see the formed tubes, flanges and rings of EASY-FLO wire. Operator slips EASY-FLO rings on tube ends, inserts ends in flange, places assembly in fixture and applies Handy Flux. While she does this another assembly in the induction coil (center) is brazed. At left is a third fixture with finished assembly. With the three fixtures she turns out a steady stream of reliably brazed heaters.

The fast, low-cost way to make WATER-TIGHT joints

For making water-tight metal joints on a commercial basis, brazing with the low-temperature silver alloy EASY-FLO is your answer on a wide range of jobs. And here are the two main reasons why: 1.—EASY-FLO brazing consistently makes joints that are just as water-tight and just as strong and lasting as solid metal. 2.—EASY-FLO brazing lends itself readily to simple production methods through which ORDINARY LABOR can reliably turn out these strong, water-tight joints at FAST RATES—all of which assures LOW COSTS.

One good example comes from the Edwin L. Wiegand Co. of Pittsburgh—the EASY-FLO brazing of their widely used CHROMALOX Immersion Heaters. Wiegand engineers worked out the simple procedure illustrated, for brazing the formed copper tubes to the copper-clad steel flanges which produces the required 100% water-tight joints with speed, reliability and economy.

GET FULL EASY-FLO FACTS IN BULLETIN 12-A

It explains exactly what this alloy does and why. Also tells you where and how you can profitably put EASY-FLO to work on your own metal joining. Write for a copy today.

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82 FULTON ST., NEW YORK 7, N. Y.
Bridgeport, Conn. • Chicago, Ill. • Los Angeles, Cal. • Providence, R. I. • Toronto, Canada
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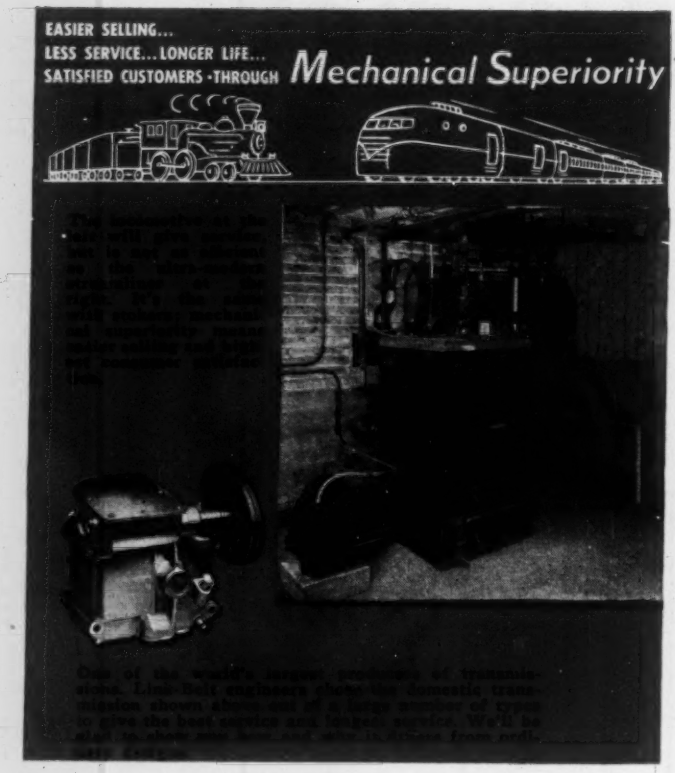


More PROFIT per DOLLAR and per HOUR INVESTED

Most dealers or distributors know the potentialities of the stoker market. The question now is: Which make of stoker?

An investigation along the lines of mechanical superiority will be profitable. Mechanical superiority means easier selling . . . less service . . . longer life . . . and the extra sales that follow from consumer satisfaction.

You'll find many mechanical features on Link-Belt stokers — developed from laboratory research and vast experience on engineering — that are exclusive. We'll be glad to tell you in detail what they are and why they are better. This goes not only for the Link-Belt Domestic bituminous (shown in the installation picture), but for the complete line of bituminous and anthracite stokers for domestic, commercial and industrial applications.

LINK-BELT COMPANY 10,288B

Stoker Division

2410 W. 18th St. Chicago 8, Illinois

LINK-BELT Magic Flame and Power-Flex STOKERS

Regular equipment includes a return to boiler system including condensate tank, float type make-up water valve, and feedwater pump and valve. Standard equipment includes necessary appurtenances so that in order to operate the unit, it is necessary only to connect steam, water, fuel, and electric lines. According to the manufacturer, no special foundation is required, and the only stack necessary is a vent from the boiler outlet to the atmosphere. The boiler shell, furnace, and tubes are built to ASME standards. Shown here is a 150 hp unit designed for firing with heavy oil.

New Dewpoint Recorder for Gases

No. 3177*—A new dewpoint recorder designed to determine automatically and continuously the amount of moisture in a gas has been announced by the General Electric Co., 1 River Rd., Schenectady 5, N. Y.

The new instrument is intended for applications where the moisture content of atmospheres and gases must be measured or controlled, such as in checking furnace atmospheres, testing city gas, or determining the humidity of gases used in factory production processes. This dewpoint recorder is a combination of heater, refrigerator, mirror and gas chamber. The test gas enters the gas chamber and comes in contact with a metal mirror. The refrigerator and heater cool or heat the mirror until a temperature is attained at which moisture in the gas forms dew on the mirror. A photoelectric eye watches the mirror, and the mirror temperature is recorded on a graph or chart the moment dew forms. Working in coordination, the refrigerator and heater hold this dewpoint temperature within a tolerance of 2 deg so that a continuous reading on the chart is achieved. The dewpoint temperature that is recorded can then be converted into the moisture content of the gas if desired. The unit can be arranged so that it will flash or sound a warning when moisture in the gas reaches too high or too low a level, or control other equipment which will dehumidify or add moisture to the gas.

Diaphragm Control Valve

No. 3178—A line of diaphragm control valves, in sizes from ½ to 1 in., is offered by Hammel-Dahl Co., 243 Richmond St., Providence 3, R. I.

Available in either 304 or 316 stainless steel, or other special corrosion resistant alloys, these valves feature a single body casting for each size. The body construction is rated at 600 psi maximum working

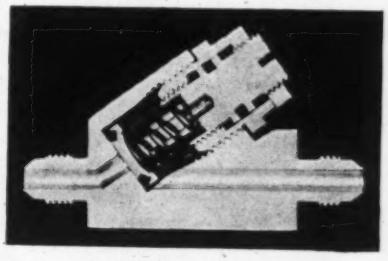
pressure at 750 F. The use of split flanges gives a Van Stone type of joint for ASA pressure ratings of 150, 300, or 600 psi. Face-to-face dimensions are in accordance with ASA standards and two-ply, neoprene diaphragms are used. The standard air pressure operating range is 2 to 15 psi, though other ranges are available. For high temperature service airfin bonnets may be obtained.

According to the manufacturer, the use of split flange construction eliminates the usual difficulties in obtaining sound castings in these alloys and also permits valves to be changed from point to point for use at different pressures by merely replacing the removable flanges.

Relief Valve for Fuel And Hydraulic Lines

No. 3179—The Aerotec Co., White Plains, N. Y., has designed a new pressure relief valve for maintaining a predetermined pressure in fuel and hydraulic lines.

The valve can be set to the desired pressure, at any time, without interrupting its operation, by means of an outside adjusting screw. This is said to eliminate the necessity for disconnecting either inlet or outlet and makes possible inspection of the entire valve assembly without disconnecting it from the main line. These new valves are available for pressures ranging from 5 to 100 psi in units having individual ranges of approximately 15 psi.

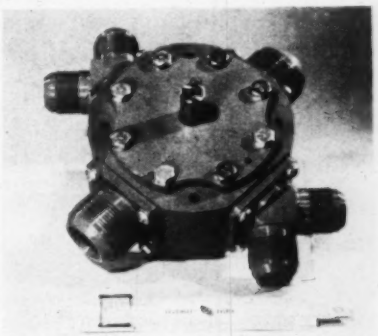


The inlet and outlet are in a straight line and overall dimensions are: length 2⅞ in., width ⅞ in., height 2 in.

Selector Valves

No. 3180—Hydro-Aire, Inc., 626 N. Robertson Blvd., Los Angeles, Calif., has recently designed and is now manufacturing a series of industrial two-way, three-way, and four-way selector valves.**

These valves are said to be capable of handling flows up to 2500 gph with negligible pressure drop. Sizes range from ⅜ to 1½ in. Units incorporate patented sealing methods which are also used in aircraft fuel valves. According to the manufacturer some of the features of these valves include: (1) extremely light weight, (2) low operating torque, (3) not affected by back pressures, (4) suitable for use at temperatures ranging from –65 F to 200 F, and (5) can be used for any type of liquid.



The valves can be positioned at 200 psi and will withstand operating pressures of 1000 psi. Units can also be supplied in small sizes for use in compressed air lines. Shown here is the four-way selector valve.

TALLMADGE ZONED CONTROLLED HEATING SYSTEMS

For better heating at less cost

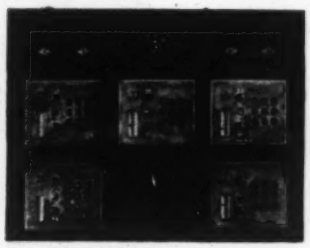


Figure 1

Figure 3

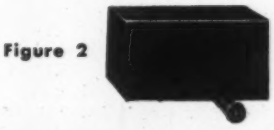


Figure 2

Figure 4

Figure 5

THE TALLMADGE equipment shown above is for a Zoned Heating System, either automatic or remote control (Figure 1). Airotherms, (Figure 2) for outside control, determine the heating requirements and set Pressure Boxes (Figure 3) to regulate the steam pressure to each zone. Zone valves (Figure 4) control the steam passing to the radiators. Orifices (Figure 5) meter the steam entering the radiators.

ADVANTAGES: Precise control of steam. Elimination of over-heating and costly waste of fuel. Low cost of maintenance. Saving on outlay for original equipment. Greater comfort to occupants due to steady heat and modulated even distribution.

WEBSTER TALLMADGE & CO., Inc. 364 Glenwood Ave., East Orange, N. J.

Pump Manufacturer Takes Over Chicago Company

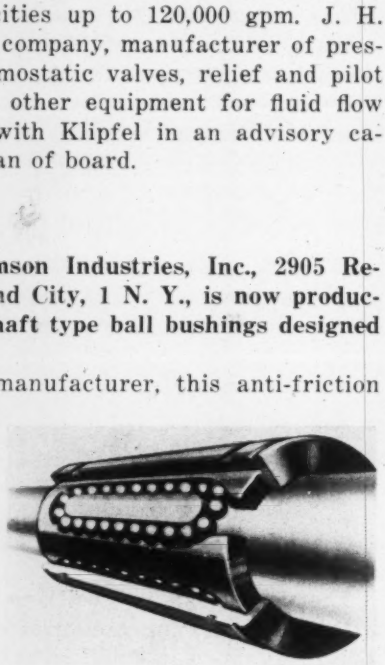
No. 3181—Economy Pumps, Inc., 1000 Weller Ave., Hamilton, Ohio, has purchased the stock of the Klipfel Mfg. Co., 2651 W. Harrison St., Chicago 12, Ill.

The Ohio concern manufactures many types of machine tools including shapers, surface grinders, hydraulic presses, and paint machinery, and, in addition, produces centrifugal, mixed flow, and axial flow pumps in capacities up to 120,000 gpm. J. H. Swan of the Chicago company, manufacturer of pressure regulators, thermostatic valves, relief and pilot operated valves, and other equipment for fluid flow regulation, remains with Klipfel in an advisory capacity and as chairman of board.

Ball Bushing for Linear Motion

No. 3182 **—Thomson Industries, Inc., 2905 Review Ave., Long Island City, 1 N. Y., is now producing a line of round shaft type ball bushings designed for linear motion.

According to the manufacturer, this anti-friction unit brings to the designer a bearing for linear motions that possesses all of the advantages which ball bearings impart to rotary motions. In addition to reduction of wear, friction, and maintenance, it is said that this device eliminates difficulties due to oxidation and gumming of the oil film on the shaft. It is also stated that these bearings permit a small length to diameter ratio without cocking and binding.



Standard units are furnished from ¼ to 4 in. shaft size. Production of some of the smaller sizes is now under way and volume production of the remaining sizes will be started as rapidly as the tooling for each can be completed.

Manufacturing Facilities for Electric Heaters Increased

No. 3183—The Edwin L. Wiegand Co., 7610 Thomas Blvd., Pittsburgh 8, Pa., is building a new plant to expand the facilities for the manufacture of "Chromalox" electric range units and electric heaters for industry.

The new building, scheduled for completion by August 1, will add 45,000 sq. ft. to present facilities, and in addition to range units, will be used for the manufacture of industrial strip, finstrip, ring, tubular, and cartridge heaters.

Welding Boiler Tubing

No. 3184—The Linde Air Products Co., Unit of Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N. Y., has reported the welding of boiler tubing in order to obtain desired lengths.

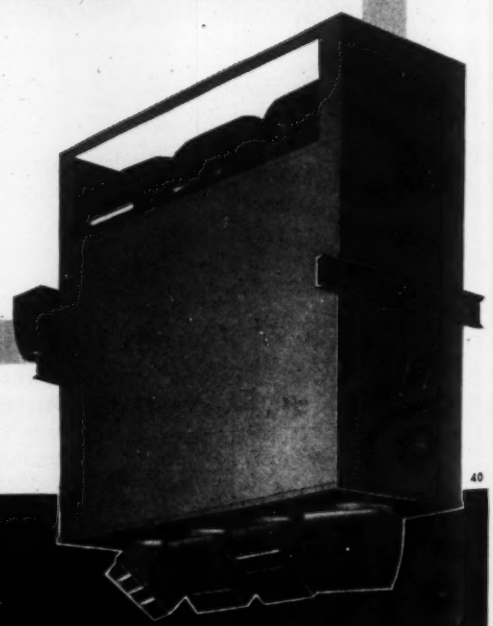
One manufacturer makes "tailor made" boiler

Save Assembly Costs with the

AIRTHERM WARM AIR DIRECT-FIRED HEATER

The Airtherm Warm Air Heater is factory assembled. No on-the-job assembly is necessary with the Airtherm Gas or Oil Fired Heater. Units are shipped from the factory, ready for installation, representing a saving in initial cost.

Nine capacities, from 650,000 to 1,950,000 B.T.U.'s.

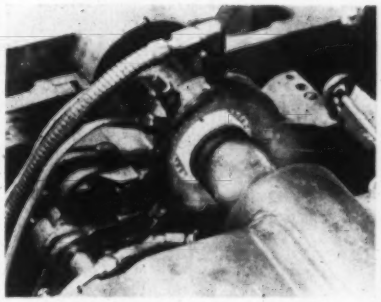


Write for bulletin describing this economical heater in detail.

AIRTHERM

MANUFACTURING COMPANY

711 S. SPRING AVENUE • ST. LOUIS 10, MO.

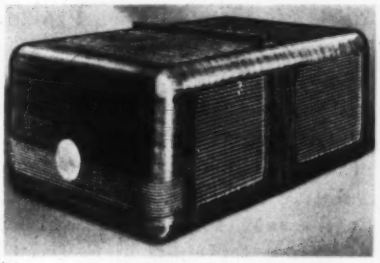


tubing of any desired length from standard tube stock by the use of oxyacetylene welding. The tube lengths to be welded are clamped in a machine and subjected to hydraulic pressure and heat is supplied from a special ring type, oxyacetylene heating head. In a short time plastic upsetting of the butted edges occurs and a weld is produced. Shown here is a close up of the beginning of the plastic upsetting.

Packaged Summer Air Conditioning Unit

No. 3185 **—A self contained, room air conditioning unit, designed to filter, dehumidify, and cool, as well as ventilate, is being manufactured by the recently organized Pacific Manufacturing Corp., 5308 Blanche Ave., Cleveland, Ohio.

The new unit, of window type, has a ½ hp motor-driven, hermetically sealed, twin cylinder, refrigerant compressor, which with the condensing coil, is in the section of the cabinet located outside the window. The room-side section of the cabinet contains filter, cooling coil, outlet duct, and motor-driven fan. The equipment is enclosed in a metal cabinet 22½ in. wide, 34½ in. long, and 13⅝ in. high.



The grained and clear-lacquered cabinet has several features, including 1 in. of insulation, an air filter, accessible for changing through a removable cover on the front, and special attachments for flush fitting and balanced weight.

The company is concentrating on this air conditioning unit for the present, but plans to manufacture larger units later.

Manufacturer of Heating Specialties in New Plant

No. 3186—The offices and plant of the Fred H. Schaub Engineering Co. have been moved to 2110 S. Marshall Blvd., Chicago 23, Ill.

The new plant provides a much needed increase in production facilities for the company's line of pumps, heat exchangers, heating specialties, and refrigeration float valves and switches. According to the manufacturer, the plant will also be used for the production of new equipment items which are to be announced in the near future.

Low Speed Axial Flow Ventilating Fan

No. 3187—A new line of low speed, axial flow type ventilating fans has been developed by the Moore Co., 544 Westport Rd., Kansas City 2, Mo.**

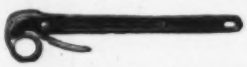
Made in 3 to 5 ft. diameters and incorporating

No pipe wrench housing repair expense with the guaranteed RIDGID

UNCONDITIONAL GUARANTEE
If this Housing ever Breaks or Distorts we will replace it Free.
THE RIDGE TOOL CO.
ELYRIA, O.
TRADE RIDGID MARK
RIGID

Millions of users know the bother and money this RIDGID Guarantee saves them

● That revolutionary RIDGID housing has long since proved that you can't damage it in normal use... even the adjusting nut in its open position won't bind, always spins easily to pipe size, 6" to 60." Precision-cut alloy jaws take-hold and let-go instantly, won't lock. Handy pipe scale on hookjaw. Comfort-grip I-beam handle. For easier work and lowest possible upkeep expense... ask your Supply House for the RIDGID.



RIDGID *Strap Wrench*

RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.

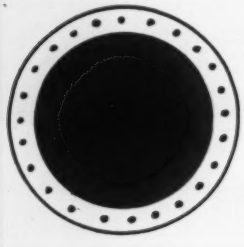
Avoid Waste
use ROLLED
CHROME LOCK GASKETING

NO need to gasket the hole when you use Chrome Lock Rolled Gasketing. Just finger press it in place. Its adhesive back stays put when and where you want it! No lace, tie, cement or tape to bother with.

Chrome Lock Gasketing is anti-wicking—anti-corrosive. Impregnated with a chromate pigmented compound, it is flame resistant.

Chrome Lock holds up under pressure of 500 lbs. per square inch at normal temperatures. It is not effected by oil, gasoline or salt. Pliable, it holds its plasticity indefinitely. It can be laminated, or lapped.

WHY PAY FOR THE HOLE?

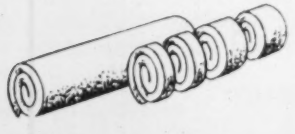


Use Chrome Lock Gasketing for piping, air conditioning, heating and refrigeration work. Write for FREE SAMPLE.

CHROME LOCK GASKETING

Available Now

Rolls Slit Rolls



Chrome Lock Gasketing

Chrome Lock

PRODUCTS RESEARCH CO.

634 S. WESTERN AVE. LOS ANGELES 5, CALIF.

guide vanes on the inlet side of the fan, the unit is available in either monel metal, for handling corrosive vapors, or in steel for ordinary ventilation use. The motor, directly connected to the fan, is equipped with permanently greased and sealed ball bearings so that the unit may be mounted in any position. The fan shown here is of the ventilating type for nearly free air delivery and is suitable for use with 220 volt, single phase or 220-240 volt 3 phase current. The motor speed is 375 rpm.

Mechanical Seal For Rotating Shafts

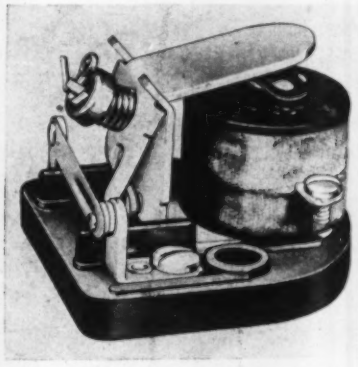
No. 3188—"Sealol CB", a mechanical seal for rotating shafts, has been announced by the Sealol Corp., 45 Willard Ave., Providence 5, R. I.**

Available for either new equipment or replacement use, the device is designed to seal leaking shafts simply, economically, and permanently. According to the manufacturer, it slides onto the shaft and is locked in place by two set screws, and the only relative movement occurs at lapped faces incorporated in the seal. The unit is available in noncorrosive construction for shaft sizes from ½ to 1 in. Other sizes may be obtained on special order.

Starting Relay For Electric Motors

No. 3189—A starting relay for electric motors, the "MS2A", which is voltage actuated and operates on the back emf of the starting winding, has been developed by Potter & Brumfield Sales Co., 549 W. Washington Blvd., Chicago 6, Ill.**

When the motor has attained speed, the relay disconnects the starting coil from the line. According to the manufacturer, no overload, with its attendant heavy current flow, can interfere with the positive operation of the device once proper motor speed has been reached. The back emf induced in the starting coil by armature rotation is the only means used to provide the disconnect. Other advantages are said to include its ability to function over a wide range of line voltage variations, rugged construction, a wide differential giving a high pull-in voltage and low drop-out, and fast contact break.



Because a centrifugal switch is not required, the

manufacturer considers this unit to be ideal for motors which are inaccessible, such as those which are hermetically sealed, and also motors subjected to heavy accumulations of dust, dirt and grease.

General Purpose Thermostat

No. 3190—A small, compact thermostat, type A, for general application has been designed by Cam-Stat, Inc., 2037 South La Cienega, Los Angeles, Calif.**

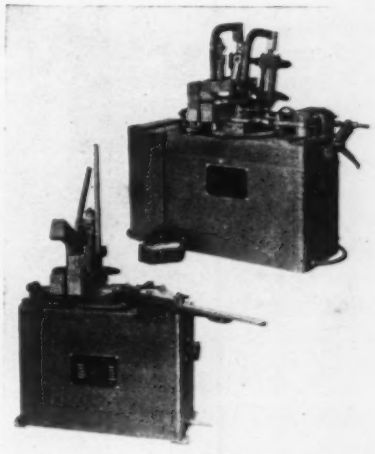
Only 1-9/16 in. in diameter and 1-7/32 in. in depth, the manufacturer claims that this device has many features formerly found only in thermostats of far larger proportions. These are said to include a high current carrying capacity (1500 Volt-Amp) without the necessity of a condenser, low differentials (as low as 2 deg), a wide selection of temperature ranges (from –50 to 350 F), resistance to vibration, and a variety of switching arrangements.

The manufacturer points out that these features make the unit suitable for many applications, such as water heaters, furnace fans, limit controls, and room thermostats.

Bench Type Butt Welder

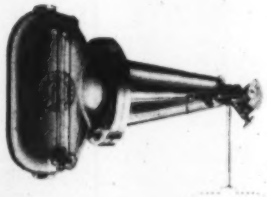
No. 3191—The Universal Welder Corp., 731 Carnegie Ave., Cleveland 15, Ohio, is manufacturing a new line of hand operated and air operated "Midget" butt welders of the bench type.**

These units parallel the 3 kva and the 7½ kva spot welders also offered by the company and are available in either 10 or 20 kva sizes with either hand or air-operated push up features. In the manual type machines these units are capable of welding intermittently up to ½ in. round steel. Air operated push up units are designed for butt welding fabricated wire products up to approximately ¼ in. steel. The air operated welders are equipped with a foot switch that starts the cycle by clamping the weldment, followed automatically by the completion of heating, welding, pushing up, and the release of the welded part.

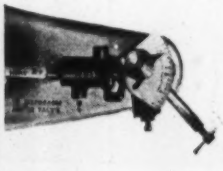


It's a sure bet...

this pilot will win a Distinguished Service Medal



Direct or reverse action by shifting an index pointer! Desired level set simply by rotating a disc! Sensitivity adjusted so that as little as 1" or as much as 8" change in level is required for full value travel! These are a few of the service advantages of K & M's radically new KONTROL-MASTER Liquid Level Pilot. It operates on air — using air only when a change in level occurs. Maximum bellows movement plus or minus .010 inches. Pressure balance valve design compensates for wear — dependable accuracy is maintained. KONTROL-MASTER will give you surer control in operating feed or drain valves on open or closed vessels — at less cost, with least attention. To assure distinguished service, KONTROL-MASTER Pilot is now standard on all Kieley & Mueller Liquid Level Controls, and may be installed on units already in use. Write for bulletin.

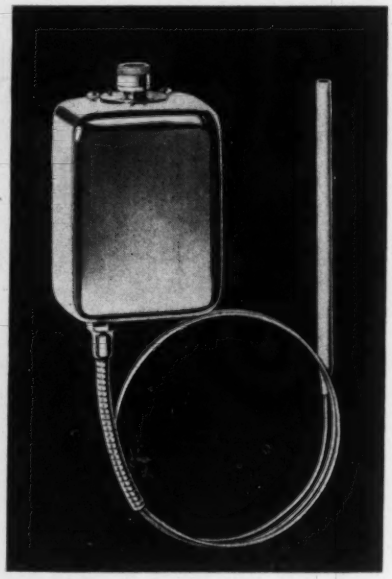


KIELEY & MUELLER, INC.
MANUFACTURERS OF PRESSURE AND LEVEL CONTROLS SINCE 1879
NORTH BERGEN, NEW JERSEY

Remote Bulb Type Thermostat

No. 3192—The United Electric Controls Co., 69-71 A St., Boston 27, Mass., is now producing a new type "O" thermostat of the remote bulb type.

It is especially designed for industrial applications requiring accurate control of temperatures over narrow calibrated ranges, and can be used for all liquids or gases noninjurious to brass, or for metal to metal applications, and can be equipped with ambient temperature compensation. Thermal assemblies can be plated or supplied in stainless steel for applications injurious to brass. Control is based on a snap action switch actuated by a solidly liquid-filled copper thermal assembly.

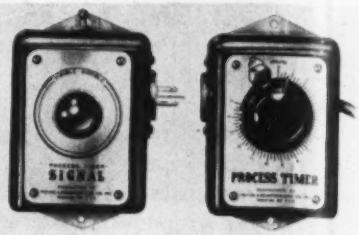


The calibrated adjustments cover any 120 or 250 deg in the range from –120 F to 600 F, and screw driver adjustments cover ranges from –120 F to 180 F, from 50 to 350 F, or from 50 to 600 F.

Process Timer

No. 3193—The type "TA" synchronous utility process timer is now in production at the plant of Potter & Brumfield Sales Co., 549 W. Washington Blvd., Chicago 6, Ill.**

Designed for timing various operations such as molding, electronic heating, plating, chemical processing, heat treating, drying, and aging, it may be used wherever accurate timing of an operation is required. The timer is powered with an instantaneous starting synchronous motor that actuates a pair of silver contacts rated at 1000 watts or 1 hp load. The dial is fitted with an adjustable mechanism so that any desired time interval up to the limit of the unit may be preset and thereafter the same time cycle will be repeated at each manual resetting, or the stop may be released and the desired interval set each time by the graduations on the dial. The minimum time interval that can be set is approximately 1 per cent of the full range of the timer. Standard time cycles are from 0 to 15 min, 0 to 30 min, 0 to 1 hr, and 0 to 12 hr. Other time cycles are available on order.



The type "A" signal indicator, offered as a companion piece, contains a buzzer and a bullseye light and may be mounted in any position.

Portable Oxyacetylene Cutting Torch

No. 3194 **—A new portable oxyacetylene cutting outfit is now available from the National Welding Equipment Co., 218 Fremont St., San Francisco, Calif.

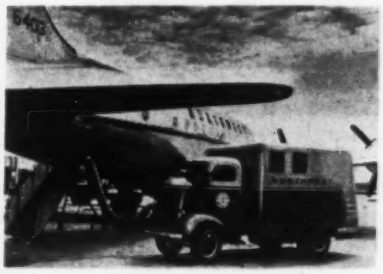
The outfit weighs 56 lb and includes two aeronautical type, shatterproof oxygen cylinders (with a combined capacity of 44 cu ft), an acetylene tank of 10 cu ft capacity, pre-set regulators, a test gage, hose, cutting torch, wrench, goggles, and gloves. This equipment is mounted in a flame resistant canvas pack which is strapped across the shoulders when in use.

According to the manufacturer, the factory pre-set regulators require no attention from the operator and all parts required for operation are connected at all times. It is said to be ideally suited for use on scaffolds and in manholes, and is offered as a standby where time is critical and portability is essential.

Mobile Air Conditioning Unit for Airliners

No. 3195—The "Climate Controller" has been designed by the Clark Climate Control Co., 1326 W. Clybourn St., Milwaukee 3, Wis., to cool, dehumidify, ventilate, and heat commercial airliners while they are on the ground.

The equipment, which is mounted on a truck, includes a 20 kw generator and its power plant, two 5 hp Chrysler Airtemp, hermetically sealed compressors, a condenser, a receiver, an evaporator, a 250,000 Btu per hr, gasoline-fired aircraft type heater, an 800 cfm air delivery fan, air filters, and auxiliary equipment and controls so that cabin temperatures are automatically controlled by utilizing the duct system and thermostat in the plane.



According to the manufacturer, the equipment has been sized to maintain comfortable cabin temperatures in the large airliners when the outside weather temperature is between –30 and 120 F. The unit can also be used to preheat airplane engines, automotive equipment, or can be used for any emergency heating or cooling problem.

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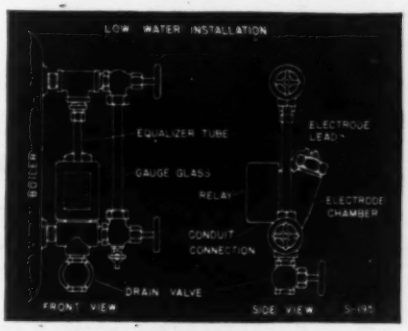
LOW WATER CUTOUTS

These electric low water cut-offs are free of moving parts, glands or seals under pressure, thereby eliminating greatest drawbacks of usual cut-offs. Designed to work satisfactorily on any type of water from spring water to brines. Large electrode area. Low current density insures freedom of spot currents. Low installation cost. Low and line voltage types available. Line voltage types with double voltage coils, permitting either 115 or 230 volts A. C. connections at installation.

L-2 Series



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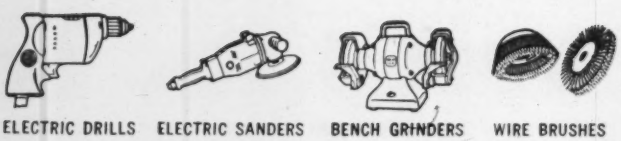
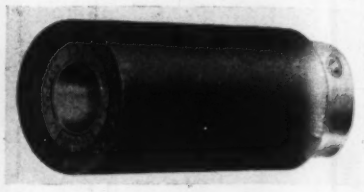


ELECTRIC DRILLS ELECTRIC SANDERS BENCH GRINDERS WIRE BRUSHES

Synthetic Rubber Flexible Coupling

No. 3196—A new synthetic rubber, flexible coupling has been developed by the Lovejoy Flexible Coupling Co., 5024 W. Lake St., Chicago 44, Ill.

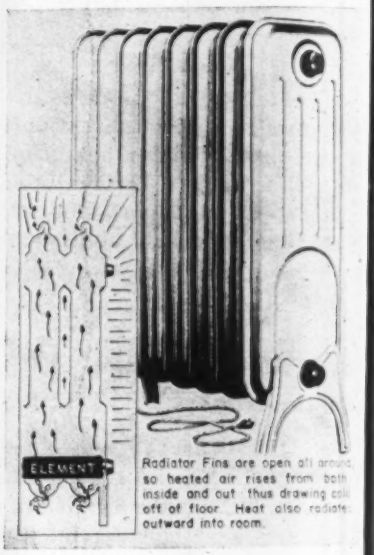
Said to be compact, easy to install, and to insure dependability, it has been designed for use on heating and air conditioning equipment and on other machines requiring maximum flexibility. Six sizes from 2¼ to 5 in. in length are available.



Electric Radiator

No. 3197—The "Co-Z-Air" line of electric radiators, using no water or other liquids has been announced by Henry J. Morton Associates, Inc., 510 Boulevard Bldg., Detroit 2, Mich.

Units are available in 5 and 8 section models, at 115 volts, plug-in type, and a 12 section model, at 220 volts, wired-in type. The 5 section model element is rated at 800 watts, the 8 section at 1200 watts, and the 12 section at 2400 watts. The 8 and 12 section models are said to be light enough to be easily portable.

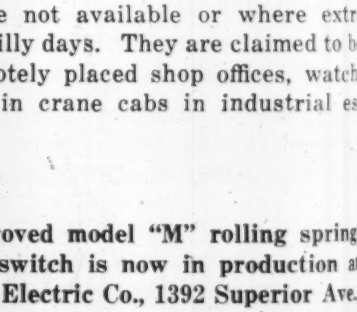

ELEMENT
Radiator Fins are open all around so heated air rises from both inside and out thus drawing cold off of floor. Heat also radiates outward into room.

The manufacturer states that these heating units are ideal for heating all rooms and places where permanent heating facilities are not available or where extra heat is required on chilly days. They are claimed to be ideal for use in remotely placed shop offices, watchmen's shanties, and in crane cabs in industrial establishments.

Improved Miniature Electric Switch

No. 3198—An improved model "M" rolling spring, snap action electric switch is now in production at the plant of the Acro Electric Co., 1392 Superior Ave., Cleveland 14, Ohio.

A new molded case is designed for greater strength by means of a fully recessed cover which is inserted clear of the four mounting holes. The size of barriers between the terminals has been increased, and to make wiring easier, heavier solder terminals are used. The



switch is made for both single and multiple assemblies and is furnished for single pole, single or double throw contacts. It is rated at 10 amp, 125 volts, a-c, and can be fitted with various types of actuators.

To Manufacture Steam Specialties

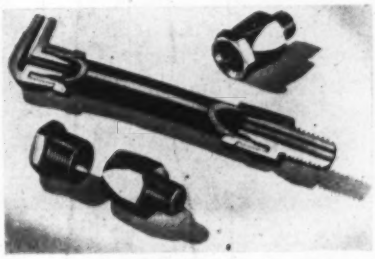
No. 3199—The Lodge & Shipley Machine Tool Co., 805 Evans St., Cincinnati 4, Ohio, has obtained exclusive license to manufacture and sell the steam specialties formerly produced by the Risselt Mfg. Co., also of Cincinnati.**

Among these products, designed for use with low pressure steam, vapor, and vacuum systems, are thermal-bellows air vents of corrosion resistant construction and boiler return traps.

Reusable Hose Couplings

No. 3200—A line of patented reusable metal couplings is offered by the Resistoflex Corp., Belleville, N. J., for hand-assembling flexible hose lines.

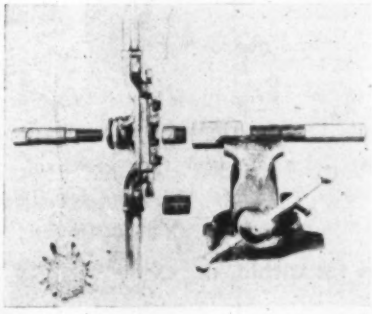
These two-piece couplings have been developed for use on air, oil and fuel lines. The coupling nut threads onto the hose, with coupling shell compressing the hose end into a safety-seal gasket. The heavy body of the fitting is said to prevent crushing or distorting of the line and large wrench surfaces are incorporated to make assembly operation simple and quick. According to the manufacturer, the fittings will not let go or vibrate loose.



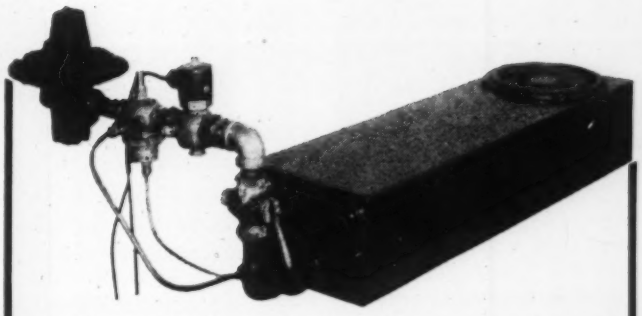
Pipe Threader

No. 3201—A new tool, designed for threading close or special length pipe nipples, is being manufactured by Starvation Laboratory, Grass Lake, Mich.

Shown here is an exploded view of the device. The nipple guide is pushed through, and the tapered threads are screwed by hand, into the half completed pipe nipple which is held in the pipe chuck. The nipple screws in further than in a standard pipe fitting, up to an adjustable stop, which after threading, is released with a pipe wrench. The completed nipple is turned out with the fingers. Practically any vise may be used to hold the pipe chuck.



The guide and pipe chuck are hardened and electroplated and are available in sizes for standard pipe from ¼ to 1 in.



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NEW BOOKS & REPORTS

Factors Affecting Heat Transmission Through Insulated Walls

The laws governing the flow of heat through insulating materials and through walls have been rather thoroughly investigated. Nevertheless, there does exist a number of controversies and differences of opinion which have not been settled because certain conditions and combinations of materials are used for which it is impossible to make accurate calculations. With this in mind, Prof. F. B. Rowley, head, department of mechanical engineering, and director, engineering experiment station, University of Minnesota, and C. E. Lund, director of research, Seeger-Sunbeam Corp., have prepared a paper, Factors Affecting Heat Transmission Through Insulated Walls, describing the scope, methods of testing, and results of a laboratory investigation.

The purpose of this investigation was not to make direct comparison between different types of insulation but to determine certain facts about the thermal conductivity of insulating materials when applied to structures and to determine whether or not the methods of application and use of the materials had any appreciable effect on their thermal values in the structure. It was found, for example, that the thermal conductivity of fill insulating materials, as investigated, is the same for a structure in a horizontal position with heat flowing upward as it is for the same structure in a vertical position with the heat flowing horizontally. It was also noted that materials, of the nature investigated, are effective in accordance with their thickness and the insulating value per inch of thickness is the same for heavier applications as for lighter applications of the same material. The authors also state that for all practical purposes, the insulating value of hand-applied granular mineral wool is the same as for machine-blown material of the same density. In calculating overall wall coefficients, the effect of wood studs, in many practical cases, may be omitted, but for walls having 3 in. or more of insulation between the studs, the effect of the studs is appreciable.

Copies of this report, Bulletin No. 24, may be obtained at 40c each from the engineering experiment station, University of Minnesota, Minneapolis 14, Minn.

Atmospheric Conditions in Australian Textile Mills

In a bulletin published by the Australian government atmospheric conditions with respect to temperature, humidity, air movement, and to a limited extent, cleanliness from dust, fumes, and steam are discussed from the standpoint of healthful conditions for workers as compared to conditions needed for certain processes in Australian textile mills. The textile processes which were studied consist of woolen and worsted spinning, weaving and finishing, and cotton spinning. Information was obtained from a survey, made between March 1942 and May 1943, of conditions in half the textile

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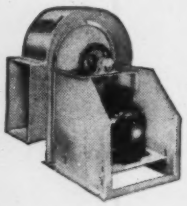
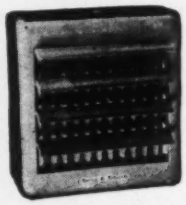
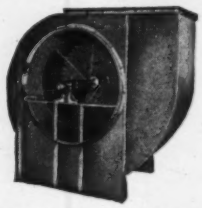


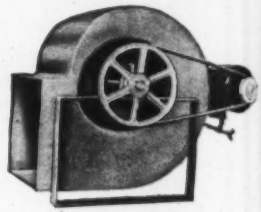
Belt Drive or Direct Drive Ventilating Units. Belt Drive shown.



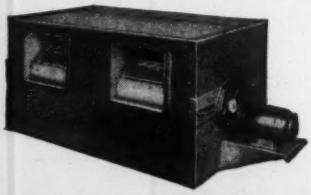
Propeller Fan Type Unit Heater. Horizontal and Vertical Projection Type.



Squirrel Cage and Power Fixed Back Curved Types. Single and double width.



Air Conditioning Furnace Blowers. Single, double or special width.



Unit Heaters. Blower type in both floor and ceiling mounting arrangements. Can be furnished with or without filter unit.

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MASSACHUSETTS BLOWER DIVISION

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mills in Australia, employing four-fifths of the industry's employees in that country.

In discussing worsted frame spinning, it is stated that the textile trade throughout the world considers ideal conditions to be provided by dry bulb temperatures of 75 to 80 F and relative humidities from 50 to 55 per cent. At these conditions static electricity does not constitute a problem. Australian manufacturers, who have given some thought to this matter, consider dry bulb temperatures from 65 to 77 F and relative humidities from about 53 to 80 per cent to be satisfactory for the spinning operation. However, the limiting conditions for the manufacturing operation are presented in terms of regain which is defined as the moisture content of the fibers expressed as a percentage of the dry weight of the fibers. The 14 per cent regain condition, which is the optimum condition, defines air temperature and humidity conditions for best results in spinning. Inasmuch as regain depends on the condition of the air, provided equilibrium has been reached, it is assumed that conditions satisfactory to the process are related to actual mill temperatures and humidities. On a chart where relative humidity of the air is plotted against dry bulb temperatures, the regain is plotted in the form of a straight line. Optimum regain is shown as a line extending from a condition of about 50 F and 52 per cent relative humidity to about 62 per cent relative humidity at 110 F. Similarly, the critical regain line for the process indicates somewhat lower permissible humidities. Similar charts are given for the other textile processes studied.

The upper limit for comfort of the workers (based on an air movement of 150 fpm) is indicated as being between 82 F at 90 per cent relative humidity and 95 F at 10 per cent relative humidity.

The chief finding of the survey was that there is a wide range of conditions which are both comfortable for the worker and suitable for the processes and that in a few Australian mills these conditions are maintained. In many mills, however, atmospheric conditions often approached the limit of workers' endurance and were unsuitable for efficient processing.

In considering some of the methods and procedures which can be used to bring about proper mill conditions, the booklet points out that in many parts of Australia evaporative cooling is practicable. Improved ventilation and mechanical cooling are also mentioned, but emphasis is placed on the use of insulation and properly grouping heat producing equipment so that heat, vapors, etc., can be removed at their source.

This 36 page booklet, Bulletin No. 6, is published by the industrial welfare division, department of labour and national service, Commonwealth of Australia.

Proceedings of 1945 NDHA Meeting Now Available

The official proceedings of the 36th annual meeting of the National District Heating Association is now off the press. The bound volume includes listings of officers and members, the president's address, reports of 19 committees, and a general subject and author index of proceedings and bulletins for the years 1935 to 1945.

Among the technical papers included is one in which

"Make Hay While the Sun Shines"
Statistics show that millions of homes and institutions are to be built . . . millions of plumbing systems installed . . . billions of ells, tees and unions used in the years that lie ahead.
That is the plumber's and contractor's golden opportunity to "make hay while the sun shines." Installations that go in smoothly, without waste of time, and with callbacks held to a minimum mean money to the busy contractor and plumber. That's a sound reason why only the highest grade materials . . . the highest grade fittings . . . should be used. "K" fittings make up fast and pull tight. They cause less trouble than ordinary fittings because they are precision cast and thoroughly inspected. Standardize on "K" fittings and save the profits less far-sighted operators dissipate on fittings that so often fail.
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G. H. Tuttle describes some 80 typical examples of fuel conservation which were reported by seven member companies. Another paper by H. F. Davis describes the reinsulation of underground pipe by pouring cell-concrete into holes in the pipe duct. Thermal conductivity and crushing strength of cell-concrete insulation, together with pipe enclosures for insulated underground and outdoor piping, are discussed in two other papers.

Copies of the proceedings may be obtained from association headquarters at 827 N. Euclid Ave., Pittsburgh 18, Pa. The price is $5.00.

ASA Year Book Now Ready

The American Standards Association has published its 1945-46 Year Book. Since this is the first issue since 1938, much new material of value to engineers, executives, and technical students is included.

Information concerning officers, members of the board of directors, of the standards council, and other policy forming committees of the association is given. It also carries such basic documents as the constitution and by-laws of the ASA, and provides a good deal of information on the set-up of the organization and how standards are developed.

The center section of the book is devoted to a listing of approved American standards and projects under development, together with an indication of the scopes of these projects and a listing of the officers and members of active technical committees.

Copies of the Year Book may be obtained free of charge by writing to the American Standards Association, 70 E. 45th St., New York 17, N. Y.

Refrigeration

The second edition of Refrigeration, Theory and Practice, by Prof. H. G. Venemann of Purdue University, is a text book on fundamental principles and applications. The book has been revised and enlarged to cover more material so as to be adaptable to a normal three credit-hour college course.

After introducing the student to the compression refrigeration system, the author discusses energy transformations and the use of refrigeration charts. The compression cycle is covered in some detail and the procedure for calculating test results is given. The common refrigerants and component parts of systems such as compressors, condensers, and controls are described.

This book differs from many college texts in that a considerable portion of the space has been devoted to operating and maintenance aspects. For example, one chapter is devoted to instructions for putting new plants into operation.

As stated by the author, this is a fundamental text. It does not cover absorption systems, sectionalizing, multiple expansion, and dual compression, nor does it contain much information on piping and many other phases of this subject. It does provide, however, a sound introduction. It is published by Nickerson & Collins Co. of Chicago, contains 336 pages, and is cloth bound. The price is $4.00.

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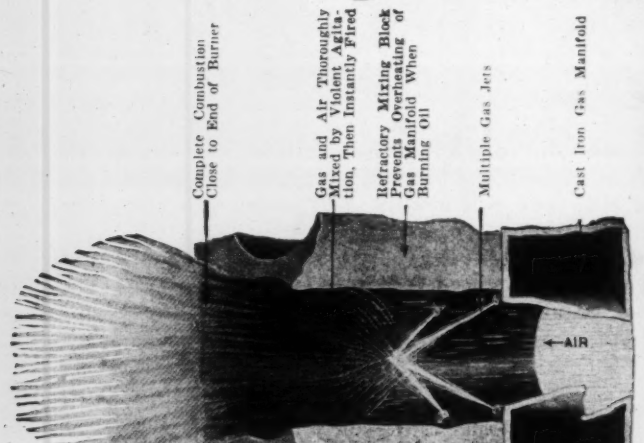
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Multiple Gas Jets
Cast Iron Gas Manifold
AIR

This section thru a Mettler Gas Burner Manifold shows how it "mixes" gas and air. It's *easy* to see why it's still the best.

The "Fan-Air Gas Burner" in adjoining picture embodies this leading patented casting design with all the other essential and desirable features of this *Fully Assembled Mechanical Draft Automatic Gas Burner.* It comes to you complete as pictured, with simple, dependable, automatic controls. No other burner *so easy to install.* Why be satisfied with less—when all these tangible advantages are so readily available.

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MEETINGS & CONVENTIONS

National Chemical Show Timed to Integrate With ACS Meeting

The 4th National Chemical Exposition will open September 10 and continue through the 14th of that month at the Chicago Coliseum. The semi-annual meeting of the American Chemical Society will be held September 9 to 13, also in Chicago, with sessions being conducted at the Palmer House, Stevens hotel, and other downtown hostelries.

The show, sponsored as heretofore by the Chicago section of the ACS, is expected to be larger in number of exhibitors and in extent of display space than ever before. In order not to conflict with the important sessions of the ACS, the industrial chemical conference, formerly a feature of the show, has been eliminated. Industrial movies, selected for their educational value, will be displayed.

Headquarters of the show is in the Coliseum Administration Bldg., 1513 S. Wabash Ave., Chicago 5, Ill.

Fall Meeting of ASME in Boston; Annual Meeting, Power Show in New York

The fall meeting of the American Society of Mechanical Engineers, 29 W. 39th St., New York City, will be held in Boston, September 30 to October 2.

The 1946 annual meeting has been scheduled for December 2 to 6 and will be held in New York City. Plans for the 17th National Exposition of Power and Mechanical Engineering, better known as the National Power Show, are practically completed. This year the show will return to the Grand Central Palace, New York City, during the week of the ASME annual meeting.

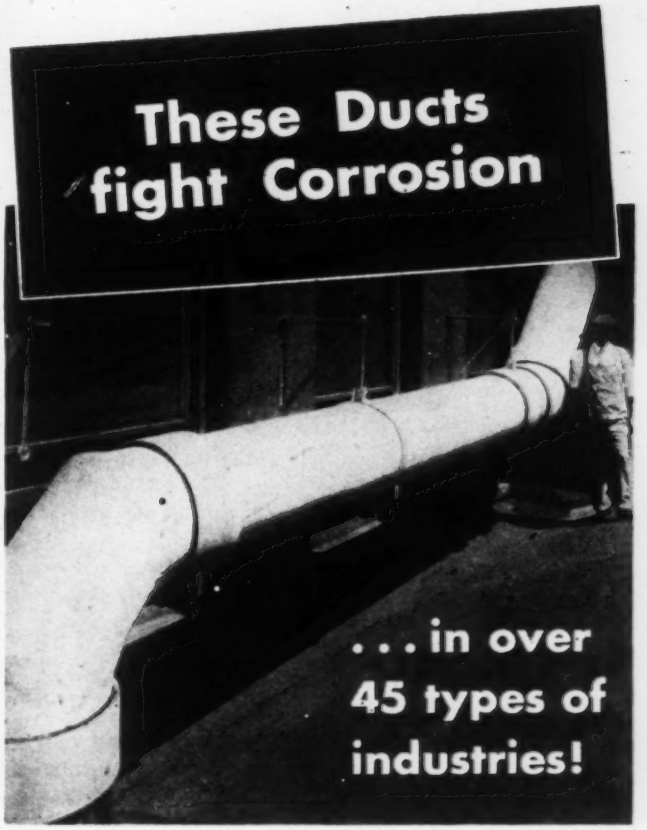
It is expected that all available exhibition area on the four floors will be occupied as over 300 leading manufacturers have already engaged space. Exhibits will consist primarily of equipment for the production of power from fuel, power transmission to machines, and some phases of power utilization.

Attendance at these expositions, which are normally held every two years, is restricted to qualified visitors, classified according to buying influence in the field of power production and use. Invitations this year will be based on revised lists, recognizing many dislocations resulting from the war and from the incidence of new industrial projects.

First established in 1922, the show is being conducted by the International Exposition Co. with permanent headquarters in Grand Central Palace, together with an advisory committee composed of leaders in power production and kindred fields.

Four Exhibition Halls to be Used for All-Industry Refrigeration Show

With 142 exhibitors already signed up, it is expected that the total number of displays will exceed 300 when the 4th All-Industry Refrigeration and Air Conditioning Show gets under way at the Cleveland Auditorium,



FOR many years, ducts, vents and stacks of Transite Industrial Vent Pipe have helped solve corrosion problems in more than 45 types of industries!

This strong, durable pipe successfully resists many of the corrosive fumes, vapors, dusts and gases encountered in industrial operations . . . providing effective and economical venting service.

Transite Industrial Vent Pipe is rustproof . . . highly weather-resistant . . . needs no paint. Made of asbestos and cement, it is light in weight . . . easy and economical to install. Available in sizes up to 36" in diameter, with a complete line of Transite fittings to assure corrosion-resistance throughout the system.

For full details, Data Sheet DS-336 is free on request. Write Johns-Manville, Box 290, New York 16, New York.

JM PRODUCTS

Typical Industries which use Transite Industrial Vent Pipe

Aircraft	Foundry	Quarrying
Automobile	Furnace	Railroad
Baking	Furniture	Rayon
Bleaching	Gas	Refrigeration
Boiler Works	Glass	Rubber
Brewing	Laboratory	Sewage Works
Canning	Laundry	Shipbuilding
Ceramic	Leather	Shoe
Chemical	Meat Packing	Smelting
Dairy	Metal	Soap
Drug	Mining	Soft Drink
Electrical	Paint	Sugar Refining
Explosive	Petroleum	Textile
Farm Machinery	Potash	Tool
Food	Pulp & Paper	Water Works

Johns-Manville
TRANSITE Industrial Vent PIPE

October 29 to November 1. With four exhibition halls in the auditorium being used for the event, over 75,000 sq ft of floor space will be occupied. This will make the show, sponsored by the Refrigeration Equipment Manufacturers' Association with the cooperation of the frozen food locker group, by far the largest in the industry's history.

Exposition headquarters is at 1107 Clark Bldg., Pittsburgh 22, Pa., also headquarters of REMA.

AWS Members Urged to Make Reservations for Annual Meeting

The 1946 annual meeting of the American Welding Society will be held during the National Metal Congress and Exposition in Atlantic City, November 17 to 22.

The exposition will be held in the Atlantic City Convention Hall, and the technical sessions, committee meetings, and social functions of the AWS will be held at the Ambassador hotel, which is now completely sold out for that week. An announcement from society headquarters indicates that other hotels in the vicinity still have rooms available. Some of these are the Ritz Carlton, Dennis, Marlborough-Blenheim, Brighton, Mayflower, Jefferson, and Madison. The society urges all members who are planning to attend and who do not have confirmation of hotel reservation to fill out and send in the housing bureau circular sent to all members last March or to write to the Housing Bureau, 16 Central Pier, Atlantic City, N. J., indicating first, second, and third choice of hotels.

The meeting this year will open with the president's reception, Sunday evening, November 17.

New Manufacturers to Exhibit at 7th International Heating and Ventilating Show

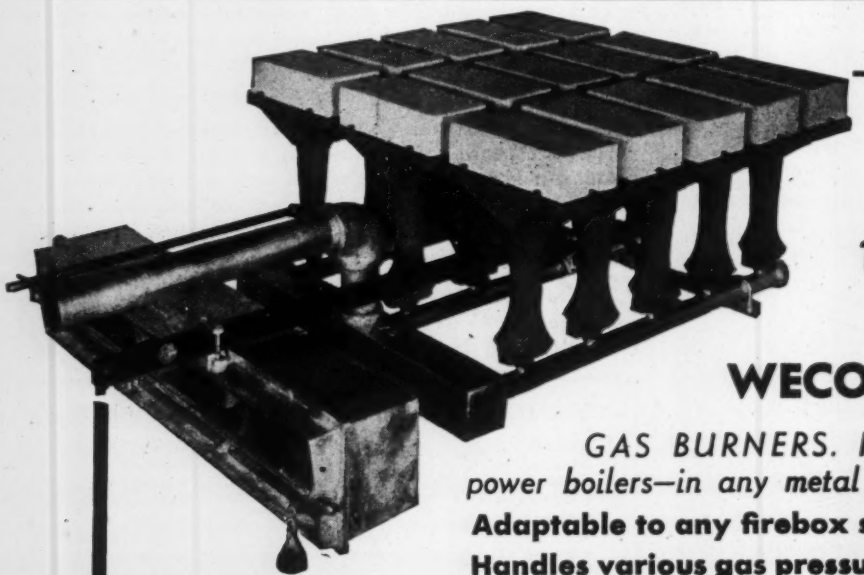
Leading manufacturers of heating, ventilating, and air conditioning equipment have already engaged over 80 per cent of the total exhibit area of the 7th International Heating and Ventilating Exposition which will be held at Lakeside Hall, Cleveland, January 27 to 31, 1947. In addition to former exhibitors, a group of new manufacturers will have displays at this show which promises to be the most stimulating and informative in the 17 years since its inauguration.

Directly sponsoring the show is the American Society of Heating and Ventilating Engineers, whose 53rd annual meeting is to be held in Cleveland concurrently. Another of the several organizations to meet in the city during the same period is the National Warm Air Heating and Air Conditioning Association.

The exposition is under the general direction of the International Exposition Co. with permanent headquarters at Grand Central Palace, New York City. General planning and policies are being formulated by an advisory committee of professional and industrial leaders under the chairmanship of A. J. Offner, president of the ASHVE.

* * * *

If you are planning to attend a meeting or convention, it is suggested that you write the headquarters office of the sponsoring society or group for a copy of the program and information about hotel reservations, etc. The street addresses of the various societies are given above for this purpose. Sometimes the dates or complete plans for such meetings are changed, and it is well, before making your own arrangements, to check with those in charge of the affair to be sure that no such changes will affect your own schedule.



50,000 to 10,000,000 B.t.u. with WECO-N.G.E. Series F600

GAS BURNERS. For use in heating boilers, power boilers—in any metal firebox or sectional boiler.

Adaptable to any firebox shape or size.

Handles various gas pressures and effects low draft loss.

The Series F600 Burner operates on straight natural gas and mixed gas to 800 B.t.u. Gives perfect horizontal distribution. Full automatic controls—that operate properly—can be easily applied. *Write for F600 Bulletin.*

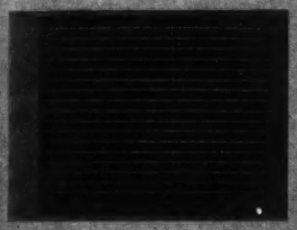
THE WEBSTER ENGINEERING CO.

TULSA —DIVISION OF— **OKLAHOMA**

Surface Combustion . . . . . Toledo, Ohio

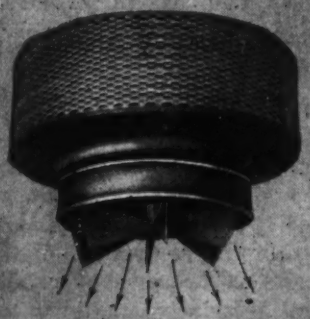
McCORD
HEATING AND AIR CONDITIONING PRODUCTS

BLAST HEATING COILS—AIR CONDITIONING COILS—ALL TYPES



All copper spiral fin tube construction with the tubes formed or bent permits uniform expansion without strain. Headers are heavy wall construction with tubes brazed into extended ferrules formed in the headers. Fins are helically wound and metallically bonded. May we send catalog?

VERTICAL TYPE UNIT HEATERS



A proven heating unit, modern in design, incorporating every unit heater advancement. McCord copper spiral fin tube construction creates air turbulence without undue restriction. Improved fan blades deliver large volume of air with minimum air noise. Guaranteed for 150 lbs. saturated steam pressure. Specify McCord.

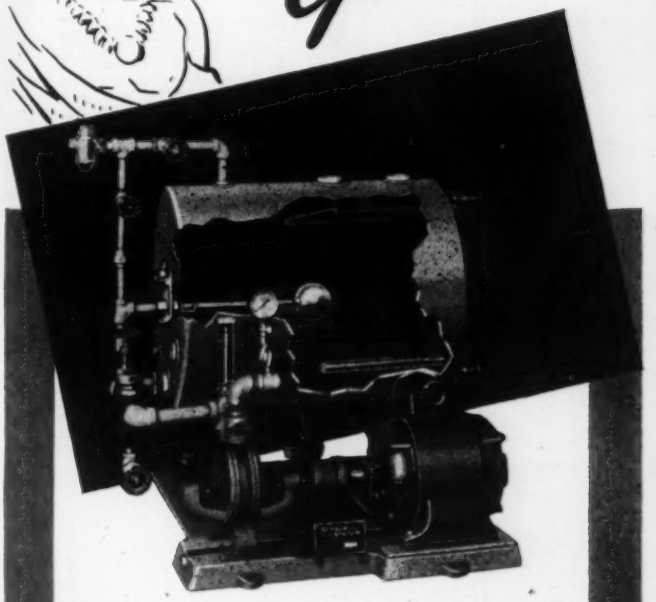
HORIZONTAL TYPE UNIT HEATERS

A time proven heating unit, modern streamlined in design, quiet, yet its rugged construction adapts it to all types of installations, guaranteed for use on No. 150 p. s. i. steam pressure. All copper heating element, individual spiral fin tubes free to expand without strain on joints. Standard motors with standard bases used. Wide range of capacities.

Save fuel with McCord Unit Heaters.

McCord CORPORATION
DETROIT 11, MICH.

MAKE YOUR BOILER AN "Indian Giver"



SCHAUB Standard Boiler Return SYSTEM

● When your *boiler* can get back hot condensate (up to 210°), *you* are receiving maximum efficiency and economy from your heating plant. And you add to that advantage when you can maintain a constant water level for uniform steam pressure and steam space in the boiler.

The Schaub Boiler Return System makes this possible. This system provides for:

1. Uniform boiler water level automatically maintained.
2. Return of all high and low pressure condensation as hot as 210° without vapor binding.
3. Addition of necessary make-up water automatically.
4. High and low water fuel cut-off protection, and high and low water alarm.

All these features mean fuel savings and increased efficiency for your equipment. Don't be without the advantages of the Schaub Standard Boiler Return System.

FRED H. SCHAUB ENGINEERING CO., INC.
2216 S. Marshall Blvd., Chicago 23, Ill.

The Key to Boiler Room Efficiency
SCHAUB SYSTEMS

FOR PERMANENT INSULATING EFFICIENCY, leading refrigeration engineers have long relied on Rock Cork's many service advantages, such as its low thermal conductivity . . . resistance to moisture, vermin, rot . . . and its imperishable, basically mineral composition. Rock Cork is made in sheet and pipe-covering form, is adaptable to every type of refrigeration construction.

Expert Application: J-M Insulation Applicators are organized to handle every detail of your insulating job. These men determine the most economical thickness of Rock Cork for your job. Their skillful application methods assure your obtaining the peak savings which only proper workmanship can make certain. Backing these construction units are J-M's years of experience in this field.

For complete information about Rock Cork, write for brochure DS-555 . . . or get in touch with your J-M Insulation Applicator. Johns-Manville, Box 290, New York 16, N. Y.

JM PRODUCT

Johns-Manville
ROCK CORK

RECENT TRADE LITERATURE

For your convenience in obtaining copies of these bulletins, see coupon on page 179. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending requests to Heating, Piping & Air Conditioning.

Activated Carbon

No. 6204—"Columbia" activated carbon, for solvent recovery, purification of air or gas, or as a catalyst carrier, is described in a new booklet published by Carbide and Carbon Chemicals Corp., 30 E. 42nd St., New York 17, N. Y. Several types and grades of this material have been developed for specific uses; all are said to be characterized by a high adsorptive capacity and selective adsorption of organic vapors in preference to water vapor. Specifications as well as suggested applications are included.

Air Conditioning for Multi-Room Buildings

No. 6205—The duct type "Weathermaster" system, recommended by the manufacturer, Carrier Corp., 302 S. Geddes St., Syracuse 1, N. Y., for commercial buildings from one to five stories high, is discussed from the standpoint of enhanced financial returns in another of the company's postwar catalogs. Designed to provide year around air conditioning, the system utilizes convector type radiators of sufficient size to provide off peak heating without the necessity of operating the central fan apparatus.

Arc Welding Electrodes

No. 6206—Electrodes designed to prevent underbead cracking in the welding of high sulphur free machining steels, high carbon steels, cold rolled steel, and cast iron are described and illustrated in a 16 page bulletin issued by the Metal & Thermit Corp., 120 Broadway, New York City. In addition to general descriptive matter of this type "HTS," lime ferritic electrode, tabulated data on physical properties and the chemical analysis are given.

Bending, Cutting, and Forming Metals

No. 6207—A new catalog (No. 46-10) illustrating and describing the line of "Di-Acro" duplicating machines has been issued by the O'Neil-Irwin Mfg. Co., Minneapolis 15, Minn. The line includes a variety of benders, shears, and brakes which are designed to duplicate bending, forming, folding, rolling, and shearing operations within 0.001 in. tolerance.

Boiler Gage Cocks

No. 6208—Dimensions, prices, and parts lists are included in bulletin WG-1815 which describes "Sealtite" try-cocks. Manufactured by Yarnall-Waring Co., 107 Mermaid Ave., Philadelphia 18, Pa., these units are designed for high pressures where long life and drop tight shutoff are required.

THE TOP FLIGHT STOKER For Distributors

Peerless FIRE-GUARD

Offers you more in PROFITS and self-selling features . . . offers more to the prospective owner in comfort, convenience and economy.

Fire-Guard is Tops in styling, lustrious beauty, sturdy construction, dependability and economical trouble-free operation.

Mass demand is here — everyone wants automatic heating. With the Fire-Guard you have the opportunity to sell fully automatic heating at an amazingly attractive profit. . . .

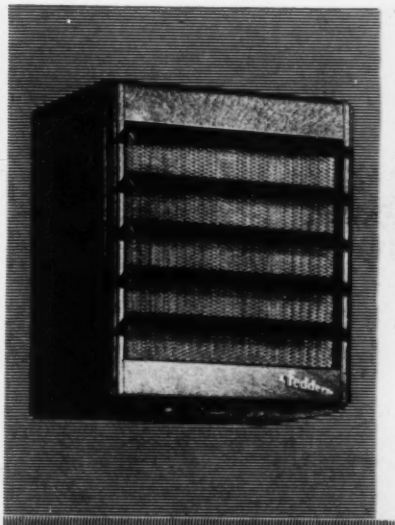
Not just another Stoker . . . Fire-Guard is Tops in quality and Distributor opportunity.

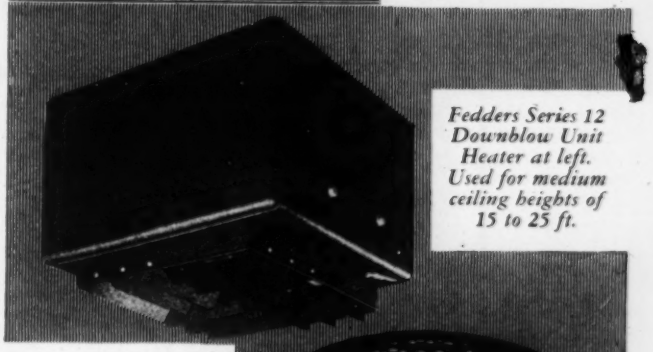
Fire-Guard offers the year's biggest merchandising opportunity — a few territories are still open. Write today for full details on the New Peerless Merchandising Plan.

Peerless
MANUFACTURING CORPORATION
INCORPORATED
LOUISVILLE, KENTUCKY
SINCE 1894

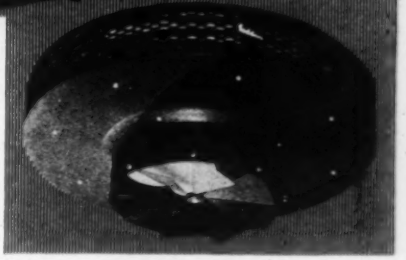
fedders HORIZONTAL DOWNBLOW Unit Heaters

Fedders Series 15 Horizontal Type Unit Heaters built in 100 to 1000 EDR capacities.





Fedders Series 12 Downblow Unit Heater at left. Used for medium ceiling heights of 15 to 25 ft.



Series 12 Downblow Models shown at right for 20-45 ft. ceiling heights.

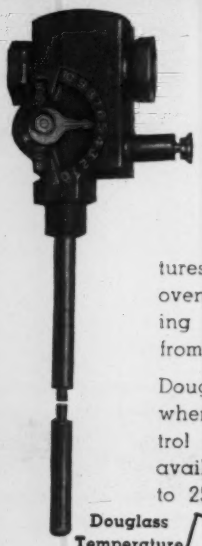
The unit heaters illustrated are typical of the wide range of horizontal and downblow types for normal and high ceiling installations. They are designed to produce comfortable heating conditions, resulting from proper final temperatures, maximum air volume and a great degree of quietness. Write for catalogs.

FEDDERS-QUIGAN
CORPORATION

BUFFALO 7, N. Y. *Heat Transfer Specialists Since 1896*

Immediate Delivery on

DOUGLASS CONTROL VALVES



SIMPLE * COMPACT
SENSITIVE * RUGGED

Douglass Temperature Controls are especially recommended for automatically controlling temperature of liquids in such applications as oil de-hydrators or pre-heaters, commercial water heaters, plating tanks, etc, and for atmospheric temperatures in such places as core ovens, cracker ovens, meat packing smoke rooms, paint drying rooms, etc Temperature control range from 65° to 800° F

Douglass Pressure Controls offer ideal service where weight, space and close pressure control are essential factors Control ranges available are for boiler pressures from 5 lb. to 250 lb. and gas pressures to 25 lb.

Douglass Temperature Control Valve

SEND FOR DETAILED FOLDER AND PRICES

Douglass Pressure Control Valve

Douglass Automatic Controls Co.

4505 FIRESTONE BLVD. SOUTH GATE, CALIFORNIA

Solve it . . .

with

SOL-VET "08"

WATER TREATMENT FORMULA

• **SOL-VET "08"** is a fast, efficient cleaner of scale, rust, slime, dirt, algae for all equipment using water for cooling. By dissolving impurities completely, they are carried out *in solution* and clogging is eliminated. Head pressures fall to normal; heat transfer is raised to maximum; full circulation is restored; life of equipment prolonged. On large jobs, shutdown time is cut to a maximum of 6 to 8 hours. **GUARANTEED EFFECTIVE.** If you find SOL-VET "08" not exactly as represented, when used according to instruction and full, accurate report is given within 30 days from date of purchase, your money will be refunded. **GUARANTEED HARMLESS** when used as directed, to all water conducting materials in water cooled equipment.

ANDERSON-STOLZ CORPORATION

1731-33 WALNUT ST. KANSAS CITY 8, MO.

Cleaning Service for Removing Sludge, Scale, Grease, and Wastes

No. 6209—"Rid-Al" service, for removing sludge, scale, grease, oil, and other wastes incidental to heat exchange equipment is described in a new folder issued by Apex Engineering Co., 205 W. Wacker Dr., Chicago 6, Ill. This chemical cleaning service is available for equipment such as condensers, water heaters, piping, traps, turbines, fan blading, evaporators, and heating and cooling coils.

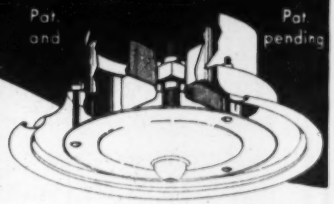
Condenser Injector

No. 6210—The "Wizard" condenser injector, which is designed to inject a sealing compound into leaking condensers, is described in a bulletin issued by the Condenser Service and Engineering Co., 95 River St., Hoboken, N. J. According to the manufacturer, the operation takes less than a minute, may be done while the condenser is in operation, and the compound used is not injurious to metal and packing.

Development of Air Diffusers

No. 6211—The research and development laboratories of the Anemostat Corp. of America, 10 E. 39th St., New York 16, N. Y., are described and illustrated in the Vol. 2, No. 4 issue of "Aspiration," the company's house organ. Facilities for controlling air temperature, humidity, volume, velocity, and pressure, together with dust content and sound levels, which are used in studying air distribution and related fields, are also mentioned.

Cut installation time in half with adjustable air diffusers



Kno-Draft *Adjustable* Air Diffusers

. . . are equipped with easily regulated unit dampers for fast system balancing and an air direction adjustment for ceiling heights and individual or seasonal requirements.

Any desired condition at your fingertips

Type K Adjustable Diffuser with Type D Volume Damper

(damper regulator protected by tamper-proof cap)

Specify Kno-Draft Diffusers for better mixing of room and supply air, more uniform temperatures throughout the occupied zone and noiseless, *draftless* air distribution.

FREE HANDBOOK: Contains clear sketches, charts, dimension prints and instructive text that simplify the selection and installation of air diffusers. Please write Dept. D-17 for your copy, using your company letterhead.

W. B. CONNOR ENGINEERING CORP.

AIR DIFFUSION AIR PURIFICATION AIR RECOVERY

114 East 32nd Street New York 16, N. Y.

IN CANADA:

Douglas Engineering Co., Ltd. W.B. CONNOR 1405 Bishop St., Montreal 25, P. Q.

Draft Control

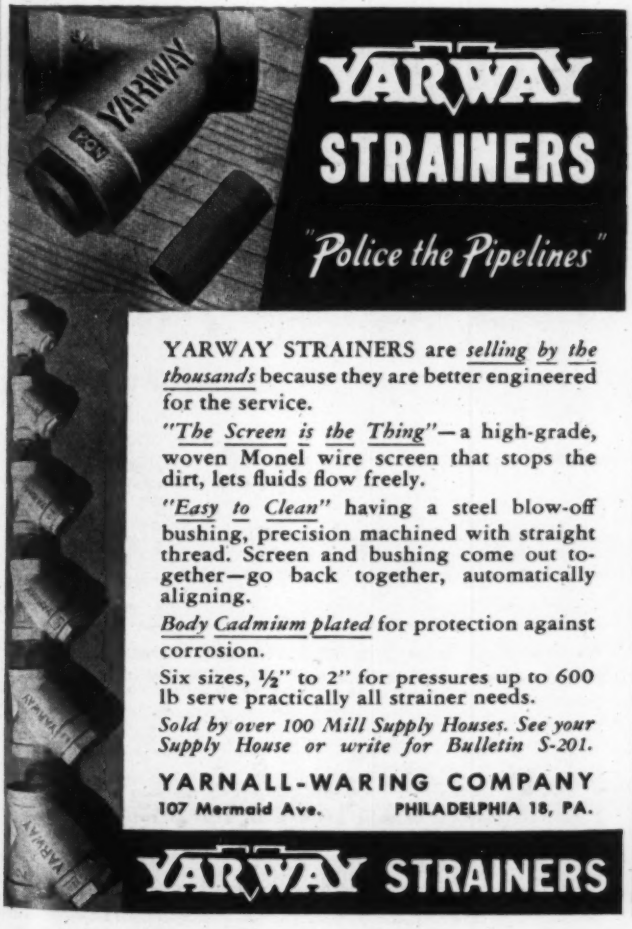
No. 6212—An electric draft control offered by the Campbell Engineering Co., Appleton, Wis., is covered in a 16 page pamphlet just issued. The application of this unit to stokers, oil and gas burners is described.

Exhaust Fans

No. 6213—Catalog No. 430-3, issued by the B. F. Sturtevant Co., Div. of Westinghouse Electric Corp., Hyde Park, Boston 36, Mass., covers the construction, uses, and sizes of fans designed for dust control, fume exhaust, and collecting and conveying materials which can be carried on a current of air. Performance tables give ratings for fans with wheels from 25 to 60 in. diameter with capacities from 680 to 20,000 cfm at static pressures from 1 to 12 in.

Filter Elements

No. 6214—"Kwick Klean" filter elements for air, water, gasoline, oil, and other fluids are described and illustrated in a 4 page bulletin issued by Skinner Purifiers, Inc., 1500 Trombly, Detroit 11, Mich. Elements are self contained cylinders made from helically wound ribbons of phenolic-resin-impregnated cellulose which have been electrically fused and polymerized. According to the manufacturer, many industries are using these filters in diversified applications such as the purification of oil, gasoline, and diesel fuel, as engine air cleaners, and as water purifiers.


YARWAY
STRAINERS
"Police the Pipelines"
YARWAY STRAINERS are selling by the thousands because they are better engineered for the service.
"The Screen is the Thing"—a high-grade, woven Monel wire screen that stops the dirt, lets fluids flow freely.
"Easy to Clean" having a steel blow-off bushing, precision machined with straight thread. Screen and bushing come out together—go back together, automatically aligning.
Body Cadmium plated for protection against corrosion.
Six sizes, ½" to 2" for pressures up to 600 lb serve practically all strainer needs.
Sold by over 100 Mill Supply Houses. See your Supply House or write for Bulletin S-201.
YARNALL-WARING COMPANY
107 Mermaid Ave. PHILADELPHIA 18, PA.
YARWAY STRAINERS

EFFICIENT
ECONOMICAL
De Luxe type WK Pressure Actuated Water Regulating Valves for Freon, Sulphur or Methyl, are pilot operated, modulating. Standard adjustable opening range from 50 to 150 lbs. Factory set to open at 90 pounds. Precision engineering and individual testing for low cost, satisfactory performance. Available in sizes of ¼ to 2 inches FPT. Simple adjustment—easily serviced.
Other sizes and types are also available.
Electrimatic
2100 INDIANA AVE. CHICAGO 16, ILL.

AGITAIR EXHAUSTERS
The Simpler Way to Ventilate
Breezes blowing from any direction over the Agitair ventilator create suction within the unit that draws stale air and vapors out of any industrial, commercial, or farm building.
Tested under operating conditions by independent research laboratories, the Agitair was proved to be most efficient — moving 50% more air at average 5 mph. wind velocity.
When there is no breeze, the Agitair does not impede natural ventilation. It is weatherproof, with no back drafts.
Available in all sizes up to 48 in. neck dia. Easy to mount on any roof or as flue cap for gas or oil-fired equipment.
• Send for new Bulletin EX-101 21-C
AIR DEVICES, INC. 17 EAST 42nd STREET NEW YORK 17, N. Y.

Blower Wheels
Do You Know...
5"
5" to 12"
12"
Janette Builds 63 different sizes of single inlet and 22 sizes of double inlet wheels, with air capacities of from 67 to 4620 c.f.m. . . . A special patented construction is used which results in an exceptionally rugged wheel that will last indefinitely.
For Over 20 Years Janette Blower Wheels have given complete satisfaction to internationally known manufacturers of air conditioning, ventilating and drying apparatus, superchargers, dust collectors, coal stokers, oil burners, air cooled engines and fire detection equipment. For Smooth, Quiet, Dependable Performance SPECIFY JANETTE BLOWER WHEELS
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Janette Manufacturing Company
556 W. Monroe St. Chicago 6, Ill.
No Other Wheel Like It
Patented Construction
Built For Hard Service

RID-AL SERVICE, scientifically developed, cleans CHEMICALLY, employing the use of perfected and tested solutions. By the skillful use of chemicals alone we can eliminate every bit of sludge and foreign matter from your entire system without INJURY and it requires no interruption in your service.

We clean and restore chemically—

CONDENSERS	STEAM FEED LINES
WATER HEATERS	STEAM KETTLES
COOLING AND HEATING COILS	CONDENSATE RETURNS
PREHEATERS	TRAPS OF ALL KINDS
HEAT EXCHANGERS	FAN BLADING
EVAPORATORS	TURBINES

Write today for literature or CONSULTATION SERVICE. No obligation, of course.

APEX ENGINEERING CO.
205 W. Wacker Drive, Chicago 6, Ill.

Filters

No. 6215—"Staynew" filters for air, other gases, liquids, and chemicals are described in a 44 page bulletin issued by the Dollinger Corp., 9 Centre Park, Rochester 3, N. Y. Pipeline filters for air and other gases, air intake filters, liquid filters, and ventilation and air conditioning filters are among the many types covered.

Flexible Couplings

No. 6216—Four basic series of couplings, three of which are for heavy duty service of varying load with the fourth designed for light duty service, are described and illustrated in a new 32 page bulletin issued by the American Flexible Coupling Co., 1801 Pittsburgh Ave., Erie, Pa. The couplings consist of two identical jaw flanges, mounted on the shafts, which engage opposite, parallel surfaces of a center member. This member is free to slide between the two jaws of each flange in directions relatively at right angles as the whole coupling rotates.

Flue Caps and Roof Ventilators

No. 6217—The new "Airjet" wind induced ventilators and flue caps are described and illustrated in a 15 page catalog issued by the manufacturer, C. R. Gelert Co., 35 N. Raymond Ave., Pasadena 1, Calif. Performance data, dimensions, weights, and the procedure for selecting the proper size of unit are included.

ATOMIZING SPRAY NOZZLES, SPRAY POND NOZZLES, and CONDENSER WATER DISTRIBUTORS
For Vertical Shell and Tube Ammonia Condensers

ALL MARTOCELLO SPRAY NOZZLES are manufactured with precision and of a design which has been thoroughly tested for maximum results and durability. They are guaranteed to give satisfaction. Successful, efficient results depend largely upon selecting the proper number, type and size of Nozzles suitable for your installation.

THE MARTOCELLO CONDENSER WATER DISTRIBUTORS are now used as standard equipment by Progressive Refrigerating Engineers in solving their Manpower problem, because they require no attention and assure users of the lowest Condenser Operating Pressures and Minimum Power Cost.

It will pay you to consult us. WRITE or WIRE for further information

Jos. A. Martocello & Co.

Gages and Thermometers

No. 6218—The industrial instruments and gages manufactured by the Electric Auto-Lite Co., Instrument and Gauge Div., Caledonia and Gillette Sts., LaCrosse, Wis., are featured in a new 40 page catalog which is now available. Included are descriptions and applications of pressure, vacuum, retard, compound, altitude, and thermometer gages. Recording gages and indicating and recording thermometers are also covered.

Heating, Refrigerating, and Air Conditioning Equipment

No. 6219—A new general catalog, containing 12 pages, briefly describes and illustrates the line of air conditioning, refrigerating, and unit heating equipment produced by the Carrier Corp., 302 S. Geddes St., Syracuse 1, N. Y.

High Pressure Pumps

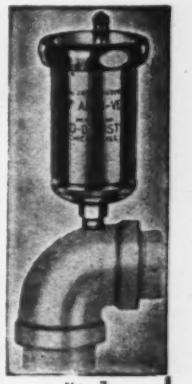
No. 6220—Horizontal, split case, multi-stage, high pressure centrifugal pumps are described and illustrated in bulletin No. C-945 issued by Economy Pumps, Inc., 1000 Weller Ave., Hamilton, Ohio. These pumps are designed for use in high pressure boiler feed systems, water supply in skyscrapers, industrial plants, etc., hydraulic elevator service and, according to the manufacturer, wherever liquids are to be handled from 75 to 500 psi and in quantities from 75 to 400 gpm.

High Pressure Valves and Welding Alloy Steel Piping

No. 6221—The May-June issue of Valve World, the house organ of the Crane Co., 836 S. Michigan Ave.,

And Keep It Out With

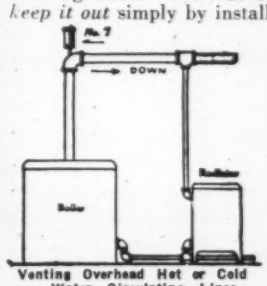
AUTO-VENT AIR ELIMINATORS



No. 7

Circulation Troubles?

Don't fight air pockets or traps in hot or cold circulating lines. "Get that air out of there" *and keep it out* simply by installing the No. 7 Maid-O-Mist Automatic Air Vent. This reliable air vent has a self-closing float-controlled valve and is designed especially for circulating pipe lines, convector radiators, unit heaters, cooling manifolds, tanks, diesel engines, or any other application where air pockets or traps retard the free circulation of liquids. Now available in bright brass finish. For pressures up to 75 pounds.



Venting Overhead Hot or Cold Water Circulating Lines

Play safe — Use them on every job.

MAID-O-MIST INC

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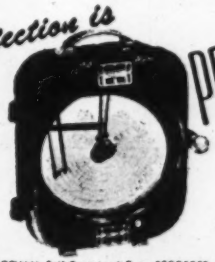

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Illustrated catalog H on request.

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PRESSURE GAUGES and RECORDERS

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Let SPEED NUT USERS *tell you why*

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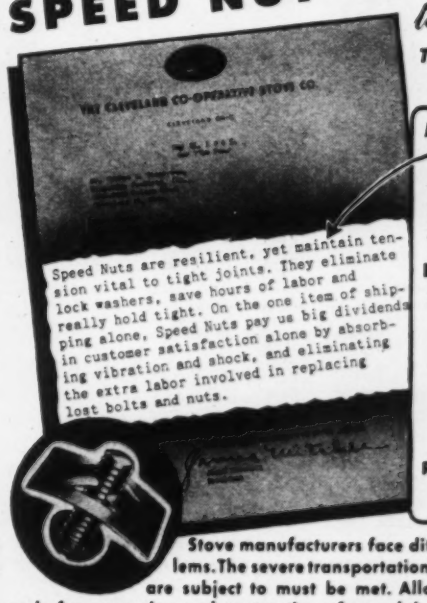
THE CLEVELAND CO-OPERATIVE STOVE CO.
Speed Nuts are resilient, yet maintain tension vital to tight joints. They eliminate lock washers, save hours of labor and really hold tight. On the one item of shipping alone, Speed Nuts pay us big dividends in customer satisfaction alone by absorbing vibration and shock, and eliminating the extra labor involved in replacing lost bolts and nuts.

ASSEMBLY ADVANTAGES

- Prevent vibration loosening
- Protect fragile materials against damage
- Eliminate lock washers
- Eliminate handling of material
- Applied faster
- Perform multiple functions
- Will not "clog" or "freeze"
- Reduce assembly costs
- Weigh less

Stove manufacturers face difficult assembly problems. The severe transportation vibration that stoves are subject to must be met. Allowance must also be made for expansion and contraction of porcelain enamel parts. • The Cleveland Cooperative Stove Co. selected Speed Nuts to solve their fastening problems, for they provide a spring tension lock that severe vibration won't loosen and yet is sufficiently resilient to prevent damage to porcelain enamel—and they eliminate lock washers, reduce assembly time and weigh less. • In writing for samples, please give complete assembly details, as Speed Nuts are made in more than 3,000 shapes and sizes.

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Conseco 15 Ton freon heat exchanger. Strand Theatre, N. Y.

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Twenty years' specialized experience designing, fabricating and servicing heat exchangers assure sound design, quality construction and economical operation with any type refrigerant. Engineering assistance gladly furnished. Write.

Let our engineering department help you with your problem

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Chicago 5, Ill., features design details and a discussion of the development work on the company's new pressure-seal, bonnet valves designed for high pressure and high temperature applications. Also included is the first of a series of three articles by E. R. Seabloom on welding of alloy steel piping. In this first article ½ to 10 per cent chromium-molybdenum alloys are considered. Characteristics pertinent to weldability, methods of welding, preheating, heat treating, and radiographic inspection are discussed.

Liquid Level Indicators

No. 6222—A brief discussion of remote liquid level indicators as used in the boiler rooms of a rayon manufacturing concern is featured in the Vol. 2, No. 2 issue of the house organ published by Yarnall-Waring Co., 107 Mermaid Ave., Philadelphia 18, Pa. A description of the company's impulse steam trap, together with brief mention of pipeline strainers and the welding of assemblies for staggered, flat glass water gages, are included.

Low Temperature Insulation

No. 6223—Eagle-Picher Co., American Bldg., Cincinnati 1, Ohio, has prepared a 28 page, illustrated booklet covering the use of the company's mineral wool insulation in the field of cold storage and refrigeration. Charts and drawings are used to supplement the data and application instructions which are included. In addition to discussing the characteristics of this insula-

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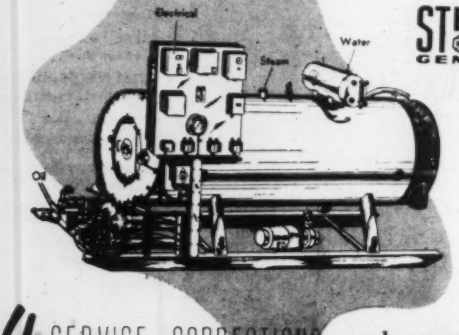
Modernize your boiler room with America's finest steam generator



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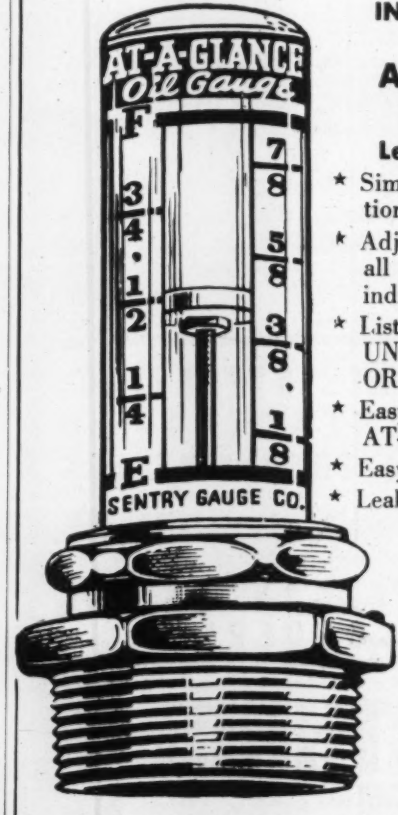

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AT-A-GLANCE GAUGES can be purchased from jobbers throughout the United States and Canada.

Write for complete details today.

KRUEGER SENTRY GAUGE COMPANY

Green Bay, Wisconsin

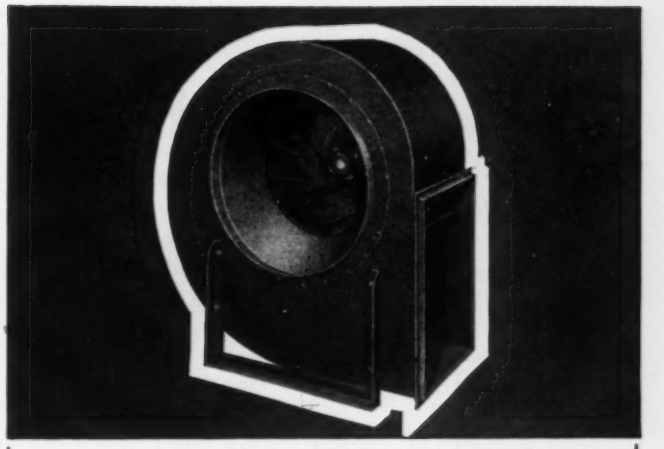
tion, the booklet stresses the importance of a vapor barrier, and recommendations for obtaining a suitable barrier are given. Also included is a chart indicating recommended storage temperatures for foods and other products.

Maintenance of Electronic Equipment

No. 6224—Preventive maintenance techniques, designed to maintain efficiency in performance, to minimize interruptions in service, and to eliminate major breakdowns, are outlined in a new handbook, Maintenance of Industrial Electronic Equipment, issued by the Westinghouse Electric Corp., East Pittsburgh, Pa. Six basic operations—cleaning, inspecting, feeling, tightening, adjusting, and lubricating—are discussed and applied to vacuum and ignition tubes, capacitors, fuses, insulators, relays, transformers, filter chokes, etc.

Multiple V Belt Drive

No. 6225—How the Dominant Drive Speeds Production, Reduces Costs is the title of a new 16 page booklet published by the Multiple V-Belt Drive Association, 22 W. Monroe St., Chicago 3, Ill. Written for the layman, the booklet presents the features of this method of power transmission in terms of operating advantages which are covered in separate chapters on delivered horsepower, drive durability, adaptability to fluctuating production schedules, etc.



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Exactly adapted to the
Exacting requirements of
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In all sizes, wheels 12 to 72 in.

And forward curve "Juniors"
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CONTROLS HEATING OR COOLING MEDIUMS
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OVER 50 YEARS OF AUTOMATIC TEMPERATURE AND HUMIDITY CONTROL

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Shown above are Auer "7000" Airo-Flex adjustable-fin type wall register, and also the DuraBilt cross-bar, interlocked construction, floor register. Below are shown a few typical Auer stamped metal grilles. Auer offers dealers and contractors a most complete line of registers and intakes for modern warm air and for air conditioned systems, and grilles for all purposes. Featuring adjustable and air directional models, as well as new style gravity types—Auer can supply ALL your register needs economically. Auer Registers are stocked by leading jobbers. Write for complete Auer Register Book—or Grille Catalog "G".

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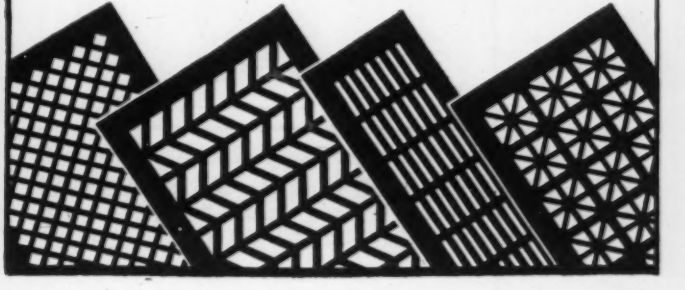
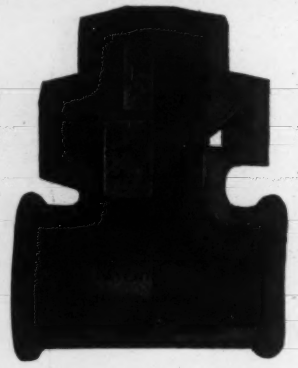


THE UNIONS WITH THE RECESSED BRASS SEAT



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Effect Big Savings in Labor

Jefferson Union Tees with union on the outlet assure labor savings and better piping jobs because they take the place of an all-female union, two nipples and an ordinary tee. Three joints are thus saved. Available in All-Female and Male and Female threads.

The brass seating in these and all Jefferson Specialty Unions is an exclusive feature which, located in a recess away from the runway of the fitting, leaves a straight bore assuring unrestricted flow in the pipe.

JEFFERSON UNION CO.
601 West 26th Street, New York 1, N. Y.

Factories at

Lexington 73, Mass. Lockport, N. Y.

Packaged Air Conditioner

No. 6226—The store type "Weathermaster," a self-contained air conditioner, is described in the latest of the postwar series of catalogs issued by the Carrier Corp., 302 S. Geddes St., Syracuse 1, N. Y. Written to invite attention to sales increases due to comfortable shopping conditions, the catalog features the business-attracting possibilities in many types of stores, shops, offices, restaurants, and taverns.

Positive Displacement Pumps

No. 6227—The Quimby Pump Div., H. K. Porter Co., Inc., 340 Thomas St., Newark 5, N. J., has released a bulletin on "Streamflow" rotary, positive displacement pumps designed for moderate or low viscosity liquids under medium pressure. Units are constructed in either gear-in-head design or with external gear and bearings.

Protective Coating

No. 6228—"Prufcoat," designed to provide protection against acids, alkalies, oil, and water, is described in a new 11 page booklet offered by Prufcoat Laboratories, Inc., 63 Main St., Cambridge 42, Mass. Made from a combination of synthetic resins and inert pigments, it may be applied by painting on with a brush, spraying, or dipping and is said to be suitable for application on concrete, structural steel, floors, pipes, tanks, and machinery.

PEERLESS GIVES YOU *More* FOR YOUR POST-WAR WATER SYSTEMS MARKET

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1 Two advanced domestic pumping systems—the Peerless Water King and the Peerless Jet Water System.

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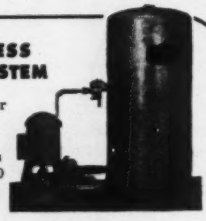
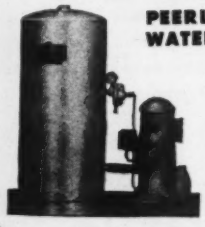


for deep or shallow wells; capacities 400 to 5,000 gals. per hour.

PEERLESS WATER KING



for shallow wells; capacities 275 to 840 gals. per hour.

Write for details of Peerless' plan to capture your share of this huge market today.

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BENDING, WELDING, FABRICATION

Many foremost manufacturers, having discovered our specialized skill in our particular line, have entrusted us with a great variety of precision pipe and tube work, including bending, coiling, expanding, flattening, brazing and welding.

Swan engineers and technicians, dealing continually with piping, can advise on your bending requirements and offer valuable suggestions on design and economical methods of installation. We invite your inquiries.

SWAN ENGINEERING COMPANY, Inc.
28-58 Nelson Street Bloomfield, N. J.

Radiant Heating

No. 6229—A new booklet on radiant heating, covering the use of copper tubing in this type of system, has been published by the Copper & Brass Research Association, 420 Lexington Ave., New York 17, N. Y. Non-technical in nature, the booklet discusses the history and development of radiant heating and enumerates some of the advantages claimed for this system in modern construction. Numerous examples of installations employing copper tubing with soldered fittings are cited and illustrated.

Safety and Relief Valves

No. 6230—Twenty designs of improved safety and relief valves are described and illustrated in a new condensed bulletin (No. 40) released by the Farris Engineering Co., 400 Commercial Ave., Palisades Park, N. J. The various types covered were developed for use in the chemical, petroleum, marine, and equipment manufacturing fields.

Stainless Steel Arc Welding Electrodes

No. 6231—Selection and application charts for the company's line of stainless steel, arc welding electrodes are contained in an 8 page folder issued by Jessop Steel Co., Washington, Pa. Current range is furnished for each type and size of rod.

How to stop wasting HEATED and COOLED air

A great percentage of the conditioned air that is exhausted because it is stuffy and stale can be converted to fresh air by the activated carbon in Dorex Air Recovery Units and recirculated.

YOU can save fuel, power and equipment, for in every case where a Dorex unit has been applied, it has converted stale, contaminated air to fresh air at a cost considerably lower than the cost of bringing in and conditioning outdoor air. A variety of Dorex unit types and sizes permits easy installation in almost every existing or planned air conditioning system.

Send for free booklet in which Merle Bennett, Chief Engineer, describes the savings and improved air quality made possible by installing a Dorex Air Recovery Unit in the existing system of the First National Bank Building, Detroit.

W. B. CONNOR ENGINEERING CORP.

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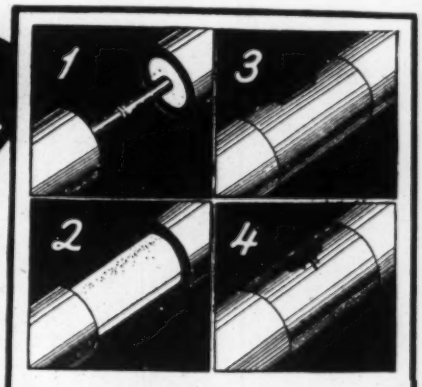

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For all your underground and exposed piping jobs you'll like DURANT Pre-Sealed Insulated Pipe. It is waterproof . . . reduces installation costs to a minimum . . . eliminates electrolysis and corrosion . . . requires very little trenching and field work . . . avoids extra cost of waste and breakage . . . comes to you ready to install. In short, D.I.P. is the *perfect pipe* for this type of job. Investigate D.I.P.! Write for details today.

4 Simple Steps

1. Field joint ready for inspection. 2. Joint covered with standard pipe insulation. 3. Durant joint casing in place ready for asphalt. 4. Asphalt poured in slot making a perfect seal.

Ready to Install

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FOR STEAM HOT WATER REFRIGERATION

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A BUYERS' GUIDE.

It tells how to specify "COMMERCIAL" products and will save you time and dollars in wires and 'phone calls.

The "Little Hand Book" gives you the information you need. It is non-technical, practical, and should be in the hands of everybody who buys or designs.

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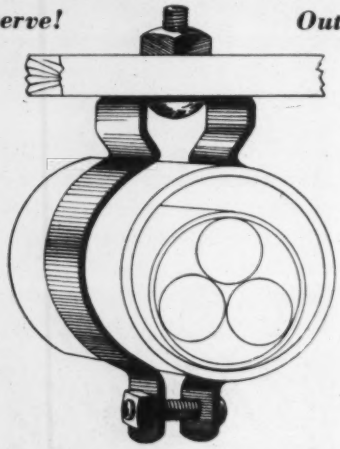
Outserve! *Outlast!*



MINERALLAC Cable, Conduit and Messenger Hangers are STEEL. Easier, quicker to install; permit speedy, compact wiring; economical. Also in Everdur . . . Porcelain Insulating Bushings available.

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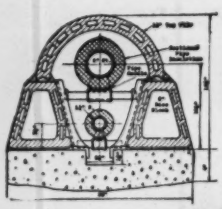

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Sold and installed by Johns-Manville Construction Units in all Principal Cities. See Sweet's Architectural File, The Heating Guide, or better still, ask for general Bulletin 381.

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- ☐ Enclosed is a rough sketch of a prospective underground pipe job.
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- ☐ Please send representative.
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Fill in Clip Out and Mail

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Steam Jet Air Ejectors

No. 6232—A new catalog, illustrating the line of "Conseco" steam jet air ejectors and showing various applications for power plant, industrial, and marine use, has been issued by the Condenser Service and Engineering Co., Inc., 95 River St., Hoboken, N. J.

Strainers and Separators

No. 6233—A new 16 page bulletin (No. 46-50) describes the line of "Adsco" strainers and separators manufactured by the American District Steam Co., 25 Bryant St., North Tonawanda, N. Y. Dimensions and list prices on Y type strainers, type T strainers, large pipe line, Macomb type strainers for water or oil service, horizontal and vertical separators for steam, air, or gas service, and receiver separators for various installation conditions are given.

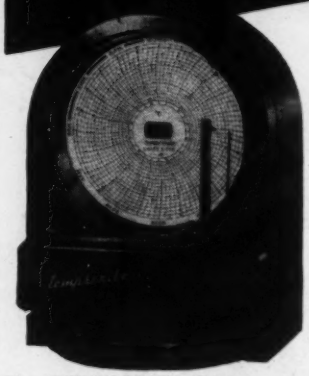
Thickness of Insulating Materials

No. 6234—A check list of recommended thicknesses for insulating materials used on piping, flat surfaces, and equipment is contained in the Vol. 16, No. 2 issue of the house organ published by the Armstrong Cork Co., 4400 Concord St., Lancaster, Pa. The type and thickness of insulation given covers a temperature range from –300 F to 2800 F. The chart is designed to facilitate quick estimating.

Unit Cooler

No. 6235—Kramer Trenton Co., Trenton 5, N. J., has issued a pamphlet illustrating the company's line of

The *tempscribe* RECORDER . . . INDISPENSABLE AID IN Balancing HEATING SYSTEMS



- SHOWS NEED FOR REPAIRS OR MODERNIZATION OF HEATING INSTALLATIONS!
- DEMONSTRATES THE HEATING COMFORTS THAT WILL RESULT FROM THE RECOMMENDED IMPROVEMENTS!
- SETTLES COMPLAINTS DIPLOMATICALLY AND KEEPS YOUR CUSTOMERS SATISFIED!

The TEMPSCRIBE Temperature Recorder makes round-the-clock records that show highest and lowest temperature for 24 hours, temperature extremes, and frequency of temperature fluctuations. Compact, self-contained; no electrical connection; requires no watching.

The TEMPSCRIBE can save your time and money on service calls—*and build your reputation for reliable, expert service.*

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. . . records on-and-off periods showing cycling frequency, length of running time, and percentage of heating capacity utilized.

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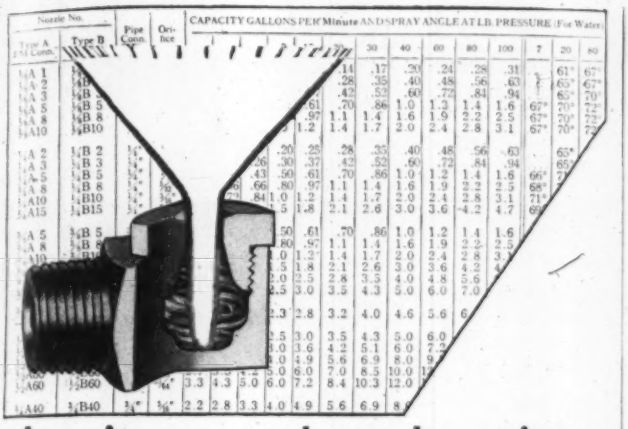

Nozzle No. Type A (1/4 Conn.)	Type B	Pipe Conn.	Orifice	CAPACITY GALLONS PER Minute AND SPRAY ANGLE AT LB. PRESSURE (For Water) 30	40	60	80	100	7	20	60
1/4A 1	1/8B 1	1/8"	1/16"	.11	.17	.20	.24	.28	.31	61°	67°
1/4A 2	1/8B 2	1/8"	3/32"	.28	.35	.40	.48	.56	.63	65°	67°
1/4A 3	1/8B 3	1/8"	1/8"	.42	.53	.60	.72	.84	.94	65°	70°
1/4A 5	1/8B 5	1/8"	5/32"	.61	.70	.86	1.0	1.2	1.4	1.6	67°	70°	72°
1/4A 8	1/8B 8	1/8"	7/32"	.97	1.1	1.4	1.6	1.9	2.2	2.5	67°	70°	72°
1/4A10	1/8B10	1/8"	1/4"	1.2	1.4	1.7	2.0	2.4	2.8	3.1	67°	70°	72°
1/4A 2	1/8B 2	1/4"	3/32"	.20	.25	.28	.35	.40	.48	.56	.63	-	65°
1/4A 3	1/8B 3	1/4"	1/8"	.26	.30	.37	.42	.52	.60	.72	.84	.94	-	65°
1/4A 5	1/8B 5	1/4"	5/32"	.43	.50	.61	.70	.86	1.0	1.2	1.4	1.6	66°	70°
1/4A 8	1/8B 8	1/4"	7/32"	.66	.80	.97	1.1	1.4	1.6	1.9	2.2	2.5	68°	70°
1/4A10	1/8B10	1/4"	1/4"	.84	1.0	1.2	1.4	1.7	2.0	2.4	2.8	3.1	71°	70°
1/4A15	1/8B15	1/4"	5/16"	1.5	1.8	2.1	2.6	3.0	3.6	4.2	4.7	69°	70°
1/4A 5	1/8B 5	3/8"	5/32"	.50	.61	.70	.86	1.0	1.2	1.4	1.6		
1/4A 8	1/8B 8	3/8"	7/32"	.80	.97	1.1	1.4	1.6	1.9	2.2	2.5		
1/4A10	1/8B10	3/8"	1/4"	1.0	1.2	1.4	1.7	2.0	2.4	2.8	3.2		
1/4A15	1/8B15	3/8"	5/16"	1.8	2.1	2.6	3.0	3.6	4.2	4.8	5.6		
1/4A20	1/8B20	3/8"	3/8"	2.5	2.8	3.5	4.0	4.8	5.6	6.5	7.5		
1/4A25	1/8B25	3/8"	7/16"	3.0	3.5	4.3	5.0	6.0	7.0				
1/4A30	1/8B30	3/8"	1/2"	3.3	3.8	4.7	5.5	6.5					
1/4A 8	1/8B 8	1/2"	7/32"	2.3	2.8	3.2	4.0	4.6	5.6	6.5			
1/4A10	1/8B10	1/2"	1/4"	2.5	3.0	3.5	4.3	5.0	6.0				
1/4A15	1/8B15	1/2"	5/16"	3.5	3.6	4.2	5.1	6.0	7.2				
1/4A20	1/8B20	1/2"	3/8"	4.0	4.9	5.6	6.9	8.0	9.2				
1/4A25	1/8B25	1/2"	7/16"	5.0	6.0	7.0	8.5	10.0	11.5				
1/4A30	1/8B30	1/2"	1/2"	5.0	6.0	7.0	8.5	10.0	12.0				
1/4A60	1/8B60	1/2"	3/4"	3.3	4.3	5.0	6.0	7.2	8.4	10.3	12.0		
1/4A40	1/8B40	3/4"	5/8"	2.2	2.8	3.3	4.0	4.9	5.6	6.9	8.0		

design and selection

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Spraying Systems Spray Nozzles give you two big advantages (1) outstanding design for effective, uniform spray distribution and long nozzle life and (2) wide range of types and sizes to meet exactly such specifications as spray angle, atomization, and impact. Let Catalog No. 22 prove these facts.

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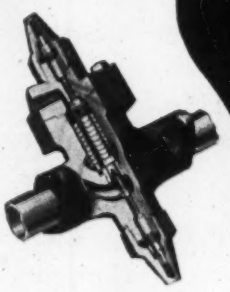

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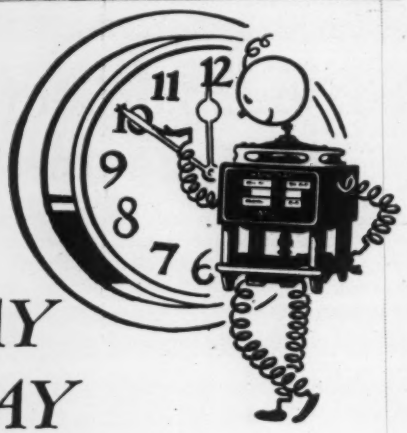

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cool – cooler – coolstream

cool

cool—*adj.*—slightly or moderately cold; *v.t.* to make cool; *v.i.* to become cool.

cool-er—*n.*—that which cools; a vessel for cooling liquids, etc.

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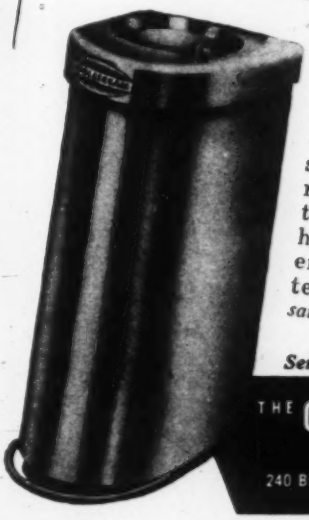

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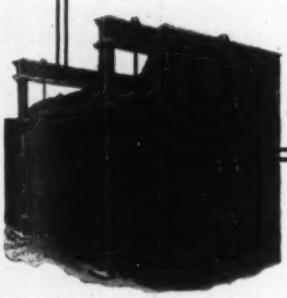

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